THE

REPERTORY

OF

ARTS AND MANUFACTURES:

CONSISTING OF

ORIGINAL COMMUNICATIONS,

SPECIFICATIONS OF PATENT INVENTIONS,

AND

SELECTIONS OF USEFUL PRACTICAL PAPERS

FROM THE

TRANSACTIONS

OF THE

PHILOSOPHICAL SOCIETIES

OF ALL NATIONS, *&c. &c.*

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CONTENTS

OF THE

FOURTEENTH VOLUME.

Page

I. Specification of Mr. ROWNTREE's Patent for a Method of applying Fire for the Purpose of heating Boilers, &c. — — 1

II. Specification of Mr. THIVILLE's Patent for a Lamp or Light, — — — 9

III. Specification of Mr. SMART's Patent for combining Masts, Yards, &c. hollow, — 17

IV. Specification of Mr. HOTCHKIS's Patent for a new Mechanical Power for the Purpose of lifting Weights, &c. — — 24

V. On Clay and Marle. By Mr. JOSIAH RODWELL, 31

VI. An Account of some interesting Experiments on the various Modes of raising Turnips. By Mr. W. JOBSON, — — — 37

VII. An Enquiry concerning Tin. By M. PROUST, 42

VIII. Observations on the real Nature of Kali undersaturated with carbonic Acid. By M. LOWITZ, 57

IX. Observations on Snow and Rain, their Influence upon Vegetation, &c. By M. HASSENFRATZ, 64

X. List of Patents, — — — 72

Page

XI. Specification of Mr. JOHNSON's Patent for a Machine with new Means of obtaining Power of the Nature of a perpetual Motion, — 73

XII. Specification of Mr. WHITTON's Patent for a Lead Saccharum, — — 83

XIII. Specification of Mr. SMETHURST's Patent for a new Lamp and Burner, — — 84

XIV. Specification of Mr. COLLINS's Patent for the Preparation and Application of sundry Articles to Marine Purpofes, — — 87

XV. Hints for managing felf-fown Oats, and faving Ploughing and Seed; and Method of converting Wheat grown in a Field to Profit. By Mr. RICHARD WESTON, — — 91

XVI. Experiments and Obfervations on the different Modes of cultivating Wheat. By Mr. HARPER, 94

XVII. Defcription of an improved Mangle. By Mr. JEE, 109

XVIII. Defcription of an improved Irifh Car. By Mr. BAKEWELL, — — 110

XIX. Account of Mr. DUCKET's Hand-Hoe, — 112

XX. Obfervations and Experiments on Copper. By M. PROUST, — — 114

XXI. On the Caufes of the vinous Fermentation. By B. G. SAGE, — — — 129

XXII. On the Pigment called Naples Yellow (*Jaune de Naples*), and the different Modes of preparing it, 134

XXIII. Conclufion of M. PROUST's Enquiry concerning Tin, — — — 140

XXIV. Lift of Patents, — — 143

XXV. Specification of Mr. SAMUEL WYATT's Patent for conftructing Bridges, Warehoufes, &c. without the Ufe of Wood, as a neceffary conftituent Part thereof with other Advantages and Improvements, — — 145

XXVI.

Page

XXVI. Specification of Dr. SHANNON's and ROBERT BURNETT's Patent for Improvements in Brewing and Diſtilling, — — 150

XXVII. Specification of Mr. DAVEY's Patent for improved Fuel, — — — 174

XXVIII. Specification of Mr. MUSHET's Patent for new Proceſſes, and new Modes of employing Proceſſes already known, applicable to Metallurgy; alſo for new Furnaces, and Improvements on Furnaces, &c. — — 176

XXIX. Account and Deſcription of an Oven heated without Flues. By Mr. HOLMES, — 186

XXX. Account of a Diſcovery of a Quarry of Mill-Stones, ſimilar to thoſe known by the Name of French Burrs. By Mr. R. BOWES, 189

XXXI. Deſcription of a Pariſh or Family Mill and Bolter for grinding Corn, &c. By Mr. J. RUSTALL, 197

XXXII. Concluſion of M. PROUST's Obſervations and Experiments on Copper, — 201

XXXIII. Memoir on the Method of preparing pyrometrical Earths of Wedgwood. By Citizen GAZERAN, — — — 211

XXXIV. Liſt of Patents, — — 215

XXXV. Specification of Mr. STATON's Patent for an Apparatus for raiſing Beer, Ale, Wine, &c. 217

XXXVI. Specification of Mr. KOOPS's Patent for refabricating Paper, — — 225

XXXVII. Specification of Mr. SAVIGNY's Patent for a Tourniquet, — — — 228

XXXVIII. Specification of Mr. HUDDART's Patent for Improvements in the Tarring and Manufacturing of Cordage, — — 231

XXXIX. Account of a Method of forwarding Vegetation by Means of Steam. By THOMAS WAKEFIELD, Eſquire, — — 235

Page

XL. Description of a Method of turning Spherical Forms in Wood in a more expeditious Manner than usually practised. By Mr. THOMAS COOK, 260

XLI. Account of the Processes employed in the Manufacture of Brass Plates at Stollberg, 261

XLII. Of the Manufacture of Soap, — — 266

XLIII. On a new Method of preparing the Acetic Acid. By Citizen BADOLLIER, — 286

XLIV. List of Patents, — — 287

XLV. Specification of COUNT DE THIVILLE's Patent for giving an independent moving Power, by Means of Hydraulick Engines; and also of constructing and employing separately several of their Parts, such as Wheels, Pistons, and Apparatus for reducing friction upon new Principles, — — — 289

XLVI. Specification of Mr. GRATRIX's Patent for dying and staining Colours upon Cotton Cloth, &c. 301

XLVII. Specification of Mr. PALMER's Patent for binding Books, especially Merchants Account Books, 305

XLVIII. Specification of Mr. BATLEY's Patent for curing and preserving Herrings and Sprats, 307

XLIX. Account of the Method of preparing Opium from Poppies grown in Great Britain, equal in Quality to the best foreign Opium. By Mr. THOMAS JONES, — — 309

L. On the Improvement of Time-keepers. By DAVID RITTENHOUSE, LL. D. — — 323

LI. On the Expansion of Wood by Heat. By the same, 325

LII. Description of a new-invented and simple Steam-Engine. By JOHN NANCARROW, — 329

LIII. Of the Manufacture of Soap, continued, 332

LIV. Observations on the Pine Tree, and Instructions relative to the Manner of extracting the Tar,

Page
and other resinous Principles from it. By M. CHAPTAL, — — — — 344
LV. List of Patents, — — — 358
LVI. Specification of Mr. CARTWRIGHT's Patent for various Improvements in the Mechanism of Steam-Engines, — — 361
LVII. Specification of Mr. POWER's Patent for a Portable Oven, — — — 365
LVIII. Specification of Mr. LONGMAN's Patent for Improvements in Barrel Organs, — 367
LIX. Specification of Mr. REDDELL's Patent for constructing Land and Water Carriages for the Conveyance of Goods, — — 369
LX. Description of a double bolted Door or Chest Lock. By Mr. THOMAS ARKWRIGHT, — 372
LXI. Description of an improved Loom to weave figured Ribbands. By Mr. CLULOW, — 374
LXII. Experiments on Evaporation. By Dr. WISTAR, 375
LXIII. Account of Experiments in cultivating Rice. By the Right Hon. Sir JOSEPH BANKS, Bart. K. B. and P. R. S. — — 378
LXIV. Effects of Equisetum Palustris upon Drains. By the same, — — — 381
LXV. On the Smut in Wheat, Blights, and the Manner in which Plants are nourished. By Sir JOHN CALL, Bart. M. P. — — 384
LXVI. On the Uses of a Varnish of Amber, and its Application to stained Woods. By M. NILS NYSTROM, — — 391
LXVII. Observations on Vinegar. By Citizen PARMENTIER, — — — 402
LXVIII. On the Manufacture of Soap, concluded, 416
LXIX. List of Patents, — — — 432

PLATES

PLATES

IN THE

FOURTEENTH VOLUME.

	Page
1. Lamp or Light, — — —	16
2. Combining Mafts, &c. hollow, — —	20
3. New Mechanical Power, — —	30
4. Lamp and Burner, — —	86
5 and 6. Improved Mangle, — —	110
7. Improved Irifh Car, and Hand-Hoe, —	112
8. Bridges and Warehoufes, — —	148
9. Furnaces and Ovens, — —	188
10. Family Mill and Bolter, — —	200
11. Apparatus for raifing Beer, &c. —	224
12. Tourniquet, — — —	230
13. Steam Houfe, — — —	258
14. Apparatus for giving an independent moving Power,	300
15 Machine for dying and ftaining Colours upon Cotton Cloth, &c. — — —	304
16. Steam-Engine, &c. — —	330
17. Improvements on Steam-Engines, —	364
18. Portable Oven, — — —	366
19. Improved Barrel Organs, — —	368
20. Double bolted Lock, — —	372

REPERTORY
OF
ARTS AND MANUFACTURES.

NUMBER LXXIX.

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I. *Specification of the Patent granted to Mr.* Thomas Rowntree, *of Great Surrey-ſtreet, Blackfriars Bridge, in the Pariſh of Chriſt Church, in the County of Surrey, Engine-maker; for his Invention of a new Method of applying Fire for the Purpoſe of heating Boilers and other Veſſels where Heat is required, and which may alſo be applied to other uſeful Purpoſes.*

Dated May 1, 1798.

TO all to whom theſe preſents ſhall come, &c. Now know ye, that in compliance with the ſaid proviſo, I the ſaid Thomas Rowntree do hereby declare, that my ſaid invention is deſcribed in manner following; that is to ſay: for heating of coppers, boilers, furnaces, ovens, and ſtoves, my fire-place is much ſmaller than heretofore made uſe of for the ſame-ſized copper, boiler, furnace, oven, or ſtove. Inſtead of placing my fire-place, according to the common practice, immediately under the boiler, or other veſſel, I place it at the front, ſide, or end, as I ſee moſt

 convenient,

convenient, in ſuch a manner as to oblige the flame to riſe in the front, ſide, or end, and paſs all round the veſſel, &c. which at the ſame time it ſtrikes the bottom of the veſſel, &c. without ſuffering the flame to paſs off in a flue, or flues, as it uſually does in the common way, and by that means ſending the heat into the flues, inſtead of its being uſed where it ought to be, namely, on the veſſels, &c.; this, my method, effectually prevents; for, by means of a ſmall perpendicular, or other opening, into a box or trap, which I call a reſervoir, and which I place horizontally or diagonally, as the ſituation may require, and is made of iron, brick, ſtone, or any other material capable of bearing heat, where a valve is placed riding on centres or otherwiſe, and ſtanding in a diagonal or other direction, as is found moſt convenient, the flame is returned or impeded in its progreſs to the chimney, and made to deſcend below the bottom of the veſſel, and paſs out at the bottom, top, or ſide of ſaid box, trap, or reſervoir, into the common chimney. This reſervoir is placed between the veſſel, &c. and the chimney. To the opening which admits the flame into the reſervoir is affixed, when neceſſary, ſliders, regiſters, or ſtops, which ſerve to increaſe or diminiſh the heat. The valve in the reſervoir is for the ſame purpoſe in another degree, which more immediately appertains to increaſing or diminiſhing the draft, which it does by moving the ſaid valve into different poſitions, as the ſpeed of the operation may require. In witneſs whereof, &c.

The above patent having been made void by a trial before Lord Eldon, and a ſpecial jury, on the

the 3d of laſt month, in the Court of Common Pleas, is inſerted at the requeſt of the patentee; who has alſo deſired us to add to it the following account of Mr. Hindmarſh's, and ſome other evidence in ſupport of his ſpecification; to which (though deviating from our general plan) we readily accede, as that evidence tends to illuſtrate the principles of the invention.

Without entering into the particulars of evidence, relative to the effect produced by my furnaces, in heating boilers, &c. and the great ſaving of fuel which the ſeveral witneſſes, who had tried them, proved to be more than one-third, and in ſome caſes nearly one-half of what is uſually conſumed in furnaces conſtructed in the old method, it will be ſufficient to ſtate the ſubſtance of Mr. Hindmarſh's evidence, becauſe he deſcribed it accurately.

Being interrogated by the counſel for the defendant, what he took to be the principle of Mr. Rowntree's invention, or in what his invention conſiſted, this witneſs anſwered to the following effect, *viz.*: That, in his opinion, the invention conſiſted in the three following things: firſt, in the peculiar mode of conſtructing the furnace, or ſetting the boiler, and of placing the fire, not immediately under, but a little in front, or at one ſide of it, whereby the flame and hot air can get acceſs to every part of the veſſel, and not only impinge with force againſt its bottom, but alſo with equal effect reverberate againſt, and violently embrace its ſides, and whole external ſurface; unlike every former contrivance, the moſt perfect of which could only cauſe the flame or hot air to act partially upon the bottom and ſides of the veſſel.

B 2 Secondly,

Secondly. He conceived that it farther confifted in the elevated fituation and fmallnefs of the aperture leading from the furnace towards the chimney; whereby the flame and hot air are impeded in their progrefs to the atmofphere, and compelled to tarry in the cavity of the furnace, and occupy every part thereof much longer than they otherwife would do. This effect in ftopping, checking, and as it were arrefting the flame and hot air in their attempt to efcape into the atmofphere, Mr. Hindmarfh confidered as not only new, but fingularly beneficial; for by this means the flame and hot air are detained in the very place where their prefence is moft wanted, and conftrained to give forth their energies with an *impetus* againft the bottom and fides of the veffel to be heated; whereas, in none of the furnaces heretofore erected, was any effectual ftop interpofed between the fire and the chimney, to caufe the flame and hot air to dwell under and round the fides of the veffel; but they paffed rapidly off into the atmofphere, either by a direct communication through the chimney, or indirectly, but almoft as fpeedily, by flues; or elfe by a drain, (as it is called), whofe aperture is equal in dimenfions to that of the chimney itfelf.

Thirdly. He was of opinion, that the invention alfo confifted in an open fpace between the furnace and chimney, called by the patentee a box, trap, or refervoir, and intended as a receptacle of the flame, hot air, and fmoke, after they have quitted the furnace, and paffed through the fmall aperture as above defcribed. This fpace, or refervoir for the flame, hot air, and fmoke, being clofed at the top and external fides, and open only at the bottom outwards, for the purpofe of permit-

ing

ing the ſmoke, &c. to paſs off into the chimney, ſtill farther checks and detains the flame and hot air in the furnace; and being itſelf conſtantly full of warm air, ſmoke, &c. cauſes the heat to be reverberated againſt the ſides and bottom of the veſſel or boiler, and effectually prevents the admiſſion of the cold atmoſpheric air from the chimney, which, on the old plans of conſtruction, is found by experience to rob the furnace and veſſel of more than half the ſupply of heat which any given quantity of fuel is capable of yielding. The valves, ſliders, and dampers, this witneſs did not conſider as eſſential parts of the invention, but merely as regulators, which, in many caſes, may be altogether omitted, without detriment to the operation of the fire. The counſel farther aſked Mr. Hindmarſh, if he had read Count Rumford's Eſſays on the Combuſtion of Fuel, &c.; to which he replied in the affirmative. The counſel then quoted a paſſage from one of thoſe eſſays, and aſked, if that did not clearly point out the principle of Mr. Rowntree's invention, inaſmuch as it made expreſs mention of *detaining* or *ſtopping* the flame and hot air previouſly to their eſcape into the atmoſphere. The witneſs anſwered, that it did not appear to him by any means to point out Mr. Rowntree's invention; for in the firſt place, it gives no diſtinct idea how that ſtoppage of the flame and hot air is to be effected, as Mr. Rowntree has done, but leaves every thing undefined and undetermined to any particular form. In the next place, he thought that the paſſage quoted might, with great propriety, be ſuppoſed to allude to thoſe forms or plans of furnaces which were then in uſe,

and

and which the Count has taken ſo much pains to deſcribe and recommend; in ſeveral of which, it is true, a trifling kind of ſtoppage is put to the progreſs of the flame and hot air, by giving them a circular or ſemicircular direction round the body of the veſſel to be heated, by means of flues or canals: but it is evident, that this kind of ſtoppage or impediment is merely in proportion to the length of the flues; that the velocity with which the flame and hot air neceſſarily paſs through them is ſo great, and the time they occupy within the limits of the flues and furnaces ſo ſhort, that their retardation is rather ideal than actual; while by far the greateſt part of the heat ariſing from the fuel in combuſtion is waſted in the atmoſphere, without having contributed its due portion to the purpoſe for which is was generated; conſequently, that all former methods of conſtructing furnaces are, in their two moſt eſſential points, namely, œconomy and effective operation, much inferior to Mr. Rowntree's.

The witneſs farther added, that, however penetrating and ſucceſsful Count Rumford has been in extending his reſearches to diſcover the moſt œconomical plans in the management of fire, and the generation of heat for culinary and other purpoſes, it does not appear from his writings, that he had a clear idea, or diſtant conception, of any thing like Mr. Rowntree's invention, until after the enrolment of his ſpecification in May, 1798. Nay, ſaid Mr. Hindmarſh, volume II, page 73, of his eſſays, the Count evidently takes it for granted, and even reaſons on the fact, which he there ſuppoſes to be unavoidable,

and beyond remedy, that the fire cannot be made to impinge againſt the ſides of a veſſel with the ſame force and effect as againſt the bottom: which is a plain proof that at the time of writing that eſſay he was totally unacquainted with Mr. Rowntree's method of applying and managing the fire; in which the very effect which the Count conſiders as a *deſideratum* in ſcience, and which appears to have been one grand object of his philoſophical purſuits, is, in fact, completed and brought to perfection. But in the year 1799, being a twelvemonth after the enrolment of Mr. Rowntree's ſpecification, Count Rumford publiſhed his tenth Eſſay, in the appendix to which, p. 93, he ſpeaks nearly in Mr. Rowntree's own words, of "the great importance of cauſing the "ſmoke *to deſcend at leaſt as low as the bottom of* "*the oven*, after it has paſſed round and over "it, before it is permitted to riſe up fully, "and eſcape by the chimney into the atmo-"ſphere."

Being again interrogated by counſel, whether or not, in his opinion, an *ordinary* tradeſman could, from a ſight of Mr. Rowntree's ſpecification alone, have conſtructed a furnace on his principles; Mr. Hindmarſh anſwered, that he thought it very probable, that there might be found ſome tradeſmen or bricklayers who were of ſo *ordinary* a capacity, as not to be able to conſtruct ſuch a furnace without perſonal and repeated inſtructions; but he was alſo of opinion, that an *intelligent* tradeſman could readily enough have conſtructed ſuch a furnace as Mr. Rowntree has deſcribed, without any other inſtructions than ſuch as the ſpecification itſelf contains. In this

latter

latter ſentiment he was confirmed by the evidence of at leaſt one other witneſs, who declared that he himſelf could have conſtructed ſuch a furnace, merely by the aſſiſtance of the ſpecification; and it appears, that ſeveral other witneſſes were in court, ready to make the ſame declaration; but it is no leſs true, that ſeveral of the witneſſes who were examined, even in favour of the plaintiff, declared themſelves incapable of underſtanding the ſpecification, or of conſtructing the furnace without farther inſtructions, having never ſeen any thing of the kind before; although what is ſingular enough, before they came into court, they all profeſſed to underſtand it perfectly, and that they could have erected the furnace by the help of the ſpecification alone. On this point the trial hinged; and the jury having declared their opinion, that the ſpecification was not ſufficiently clear for an ordinary tradeſman to act by, Lord Eldon obſerved, that the trial could not proceed any farther, but that the plaintiff muſt be *nonſuited.*

Thus the patent becomes the public property, or void, as to the excluſive intereſt of the patentee.

II. *Specification of the Patent granted to* Joseph Gaston John Baptiste de Thiville, *of Boulton-ſtreet, Piccadilly, in the County of Middleſex, Gentleman; for his Invention or Diſcovery of a Lamp or Light.* Dated May 26, 1800.

WITH A PLATE.

To all to whom theſe preſents ſhall come, &c. Now know ye, that I the ſaid Joſeph Gaſton John Baptiſte de Thiville, in compliance with, and conformity to, the ſaid proviſo, do hereby particularly deſcribe and aſcertain the nature of my ſaid invention, as followeth: I do declare, that the ſame conſiſts of a new combination and application of different dioptrical and catoptrical principles, calculated to produce the double advantage of increaſing light and diminiſhing expence. It is capable of being applied either to lamps for the ſtreets and ſhops, or to bougies or candles for the interior of houſes, and in lighting chambers, rooms, halls, ſtaircaſes, public highways, playhouſes, cellars, paths, paſſages, vaults, pits, caverns, caves, ſubterraneous paſſages, and all other places requiring light by reflection; and alſo in the lighting of coaches, landaus, chariots, chairs, and other carriages. Then, inſtead of the ſpherical, convex, and concave forms, hitherto employed to refract and reflect light, I make uſe of oblong, or nearly or quite cylindrical ones, ſometimes a little eliptic, and ſometimes a little conic, according to the exigency of the caſe, as ſeen in A 2, A 3, A 4, (Plate I.) and ſubſtitute cylinders, or cylindrical

drical ſegments, in the place of convex or concave ſpheres.

These cylinders I elevate vertically, obliquely, and ſometimes horizontally, oppoſite the flame, in the direction I mean the body of rays to fall. Fig. 1, repreſents the elevation, and Nos. 1, 2, 3, 4, 5, 6, the different plans I give to the inſtruments of refraction, the dimenſions of which I proportion to the actual volume of light. Theſe inſtruments, if not too thick, are of ſolid glaſs, as in Nos. 5 and 6, and in all caſes may be of hollow glaſs, filled with any tranſparent fluid whatever; if the light is to be extended horizontally, Fig. 1 muſt be employed; if downwards, as for example, the lamps in the ſtreets, the upper part of the cylinder muſt be terminated by part of an ellipſis or cone, truncated or not, or ſimply rounded, as Figs. 2 and 3. I terminate, in the ſame manner, the inferior part of the cylinder, or ſegment of the cylinder, if the light is to be directed upwards, as Figs. 4 and 5; and, finally, I terminate both the ends in the ſame manner when I want to produce a ſtrong light to be reflected both above and below, as a lamp placed in the middle of a ſtaircaſe, Figs. 6 and 7. If inſtead of increaſing by refraction, the apparent ſize of the flame, I prefer increaſing apparently the number of theſe flames, the convex part of the refracting inſtrument muſt be cut in as many facets as I wiſh to produce bodies of light. This method may be applied to all the forms of the plans Fig. 1, but I prefer making uſe of them only with cylindrical ſegments, Figs. 8 A and B. Theſe I compoſe of one or ſeveral pieces of glaſs, placed one above the other, as 1, 2, 3, B; hence, if there are ſix facets, ſix flames will be

be produced a little increaſed, each of which will give at leaſt as much light as the actual flame itſelf. If I wiſh to direct the light according to the different ſituations above ſpecified, in Figs. 2, 3, I terminate the one or the other, or both the extremities of the cylinder, or the ſegment of the priſmatic cylinder, by a pyramid, or a portion of a pyramid, either truncated or not truncated, as Fig. 9; or I have it ſimply rounded at both ends. The light of a lamp in the ſtreet is conſiderably increaſed, and hence their number, and conſequently their expence, may be conſiderably diminiſhed, upon the following principles of my invention. In a common lamp of glaſs, Fig. 10, I introduce three bottles of about two inches and a quarter diameter, and five or ſix inches long, as Fig. 11, which I fill with any tranſparent fluid. I arrange them in the order 1, 2, 3, Fig. 10, and fix the burner C in ſuch a manner that the flame A may be about an inch from the bottles 1 and 3, which are to light the pavement, and a little more than half an inch from the bottle 2, which is to light the middle of the ſtreet. I faſten theſe bottles within a tin frame, Fig. 12, Nos. 1 and 2, compoſed of ſeveral circles, A, B, C, D, E, F, Fig. 12 No. 2, which ſerve to contain the bottles againſt a partition A B C, Fig. 12 No. 1, which reaches to the bottom of the lamp, and divides it, in a vertical manner, towards the two-thirds. This frame is covered with another plate of tin, Fig. 13. A B ſhews the poſition of the upright partition and 1, 2, 3, the parts of the tin covering which correſpond to the bottles that are underneath. All this preparation is ſoldered on the tin rim which belongs to the lamp, and all the circum-

ference X C Z, of Fig. 12, No. 1, is connected to the interior part of the lamp, and the small space between and above the bottles is likewise covered with cement, so that neither smoke nor dust can penetrate in any of the parts 4, 5, 6, Fig. 10. Hence in this lamp there is only the space A, that is to say, the parts of the bottles which are opposite to the flame, the interior A B C of the lamp, and all the exterior part, as usual, that require cleaning. Fig. 10, No. 2, also shews the disposition to be adopted for a burner with two or even three wicks; and Fig. 10, No. 3, shews a lamp with two cylinders only. This whole apparatus may be made with plaster only, instead of tin, observing that a hole must be contrived in some part of it, which must not be stopped until the plaster is entirely dry, to prevent the dampness tarnishing any part of the bottles or lamp in the inside of the apparatus. If I had made use of segments of cylinders, there would have been space sufficient to introduce the torch of the lamplighter, but as I take cylindrical bottles the space becomes narrower. To remedy this inconvenience, I have formed a hole, furnished with a little tin pipe, in A, Fig. 14, in the rim A B of the lamp, and introduce into this pipe a small rod of iron D B, terminated by the hook B; on this hook rests the wire which supports the burner C; when the lamplighter cleans the lamp, he must leave the burner in the position B C, and when he returns to light it he must raise, with his left hand, the top of the lamp, which must have a notch, into which the little iron bar is introduced; the lamplighter then introduces his torch, lights the lamp, replaces the lid, and, with the same hand, pushes the little iron

iron bar D B, which causes the burner to take the situation marked by the pointed line. C, shews separately the form of the burner, so constructed that, by pushing the iron bar, the said burner can take no other place than the one it is designed to occupy. Fig. 15, shews that the pavement is lighted by the two bodies of light A B and A D, and the middle of the street by the body of light A C, longer than the former, because the flame A is nearer the bottle 2 than the two others; but it being likewise necessary to light the two spaces which separate these three bodies of light, I introduce, opposite the top of the bottles 1 and 3, pieces of common looking-glass Y and X, Fig. 15, as seen in elevation, Figs. 16 and 17. These glasses are so inclined and placed as to reflect on the middle of the street, (in the direction Y O and X V, Fig. 15,) the body of light refracted and magnified by the bottles 1 and 3. In case I wish to light a space more extended in breadth with less intensity of light, I shall make use of the form represented Fig. 22, of which A is the vertical elevation, B the profile, C the plan; so that, by this my invention of adopting cylindrical transparent bodies of glass, of making the light pass through fluids, and having it reflected by pieces of looking-glass, in such number and directions as wanted, a whole street may be lighted in such a manner that a single lamp produces a greater effect than six of the present construction; and that the streets may be perfectly well lighted in only preserving the third, or at most the half, of the present number of lamps, by placing them at a distance of one hundred and twenty feet or more from each other. These principles admit of such infinite

nite variations, and their combinations may be ſuch, that, with a very ſmall number of bougies, candles, or lamps, and even with one only, a large room may be as well lighted as with a very conſiderable number of lights, and without any part remaining in obſcurity. I will give but few examples of it. Let us ſuppoſe, for inſtance, a vertical ſection of a cylindrical vaſe, Fig. 18, the top and bottom of which are a little rounded, *a a*, *b b*, *c c*, *d d*. I fill it with a tranſparent fluid, and introduce into it a glaſs tube, P R; in the bottom of which ſtands the burner V; to X is added a ſmall pipe X T, made of glaſs or metal, to which is adapted in T, another metal pipe T Y, which ſupports the lamp S. This piece turns in T on a hollow hinge, and makes, with the part T X a ſort of ſyphon, by which the oil is kept on a level in V and S. When I want to introduce the oil in V, I elevate the lamp S, to S 2, till both tubes Y T and T X are filled. The lamp being put again in its former ſituation, the oil continues running into V ſo long as the wick burns, and till S is empty; ſome attention is only required to raiſe, from time to time, the lamp a little towards S 3 in proportion to the conſumption of oil, in order to keep it on the ſame level with Y S. In this ſtate the image of the light will be but little amplified; but I cover the outſide of the parts *a a*, *b b*, *c c*, *d d*, with a reflecting ſurface, which reflects the light in the inſide of the vaſe ſo that the whole floor is lighted by *a a* and *b b*, and the whole ceiling by *c c* and *d d*, which diffuſes into the room an equal and ſoft light, diſpoſed in ſuch a manner that the flame A only is perceptible to the eye, which even, if neceſſary, can be concealed.

Inſtead

Inſtead of a ſyphon, the communication can be eſtabliſhed by a hole practiſed in the glaſs; with a cock and ſtopper, B, Fig. 19; but the firſt method is far preferable, unleſs one of Argand's lamps is to be made uſe of: in all caſes another pipe, L, Figs. 18 and 19, muſt be contrived, in order to introduce air under the flame. If I wiſh to fix this lamp againſt a wall, I cover half the cylinder with a reflecting ſurface, as *a b c d e f*, Fig. 19, ſo that the light is reflected in every direction. If inſtead of a common lamp, I wiſh to introduce one of Argand's, a candle, or bougie, the internal pipe muſt be ſo diſpoſed, that it forms one-piece with the cylinder, which is to be open both ways, A and B, Fig. 20. In all caſes except the laſt, the internal pipe may be approached or removed from the reflecting ſurface, ſo that it may be placed in its proper focus. By theſe means the effects of the combination of both the principles of refraction and reflection, will be in a compound ratio of the amplification of the image by the firſt refraction; of its ſecond amplification by the reflection, which will itſelf be ſtill more magnified by a ſecond refraction much ſtronger than the firſt. A very great advantage to be derived by my invention is, that the reflecting ſurfaces never want to be cleaned or repaired, they being always covered with water, which prevents their getting dirty or damaged in any way whatever. Another method will be productive of a ſtill greater effect. It conſiſts of three lamps, candles, or bougies, each introduced between ſix cylinders or facetted ſegments. Fig. 21, ſhews the horizontal plan of ſuch an apparatus, ſuſpended in the middle of a room, each part turns on a pivot, placed under the

the flames A, B, C, and the whole turns on another pivot D; the use of which is to direct the light at pleasure. Now, supposing the divergence of each refracted image to be eight feet wide, at eighteen feet distance, the refringing glasses being eighteen in number, the whole of the lighted space will be one hundred and forty-four feet, which forms the surface of a room thirty-six feet square. I have adopted the method of fixing the apparatus, Figs. 10, 12, and 13, in the lamp, with the sole view of answering the objections made to me by the surveyors of the town, and the surveyors of the committee of sewers, both entrusted with the examination of my plan, as presented to the said committee for better lighting the city of London. The objection is, that in case this apparatus be free and independent of the lamp, (as seen in Fig. 12, No. 3, for one wick and two cylinders, and No. 4 for two wicks and one cylinder, only the conic part, *a b c*, of which is covered with a reflecting surface,) the risks of greater fragility would be the consequence of this method, which I lay open here that the public may judge and choose. I have sufficiently demonstrated the great advantages to be derived in and by my said invention, both in point of increasing light and diminishing expence, by adopting my cylindrical forms, and a fluid through which the light is refracted and magnified. It is to be observed, that the refringing powers of fluids in general are less than that of solid glass; but that loss is considerably repaired by the greater transparency of the fluid, the parts of which are more homogeneous than the glass, which always contracts both in fusion and working; defects and inequalities which produce very

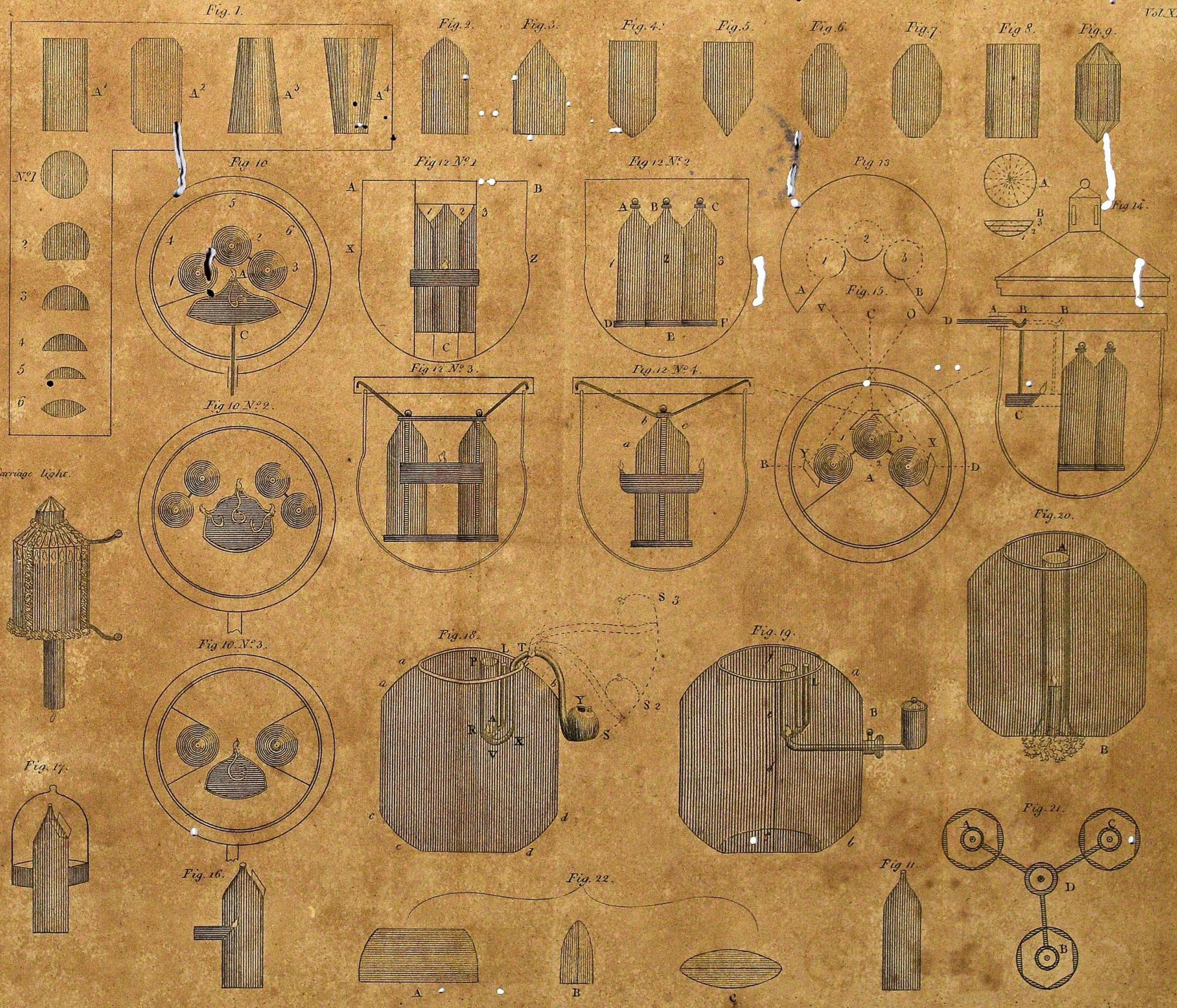
Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 8.
Fig. 9.
Fig. 10
Fig. 12 Nº 1
Fig. 12 Nº 2
Fig. 13
Fig. 14.
Fig. 15.
Fig. 10 Nº 2.
Fig. 12 Nº 3.
Fig. 12 Nº 4.
A Carriage light.
Fig. 20.
Fig. 10 Nº 3.
Fig. 18.
Fig. 19.
Fig. 17.
Fig. 21.
Fig. 16.
Fig. 22.
Fig. 11.

often an imperfect and dazzling image of the flame.

For farther explanation, and in order to illustrate and elucidate still more fully the present statement, I refer to, and have added, by way of schedule, to this my specification, the particulars of the plans, drawings, and devices, of the different lamps and lights of this my invention; referring thereby to the different letters, figures, and forms, herein-before specified, abstracted from a pamphlet* or treatise written by me on the subject. In witness whereof, &c.

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* This pamphlet may be had at the office of this publication; where, specimens of the lamps may be seen, and orders are received for the Patentee.

III. *Specification of the Patent granted to Mr.* George Smart, *of Camden Town, in the Parish of St. Pancras, in the County of Middlesex, Timber Merchant; for his Invention of a Method of combining Masts, Yards, Bowsprits, &c. hollow, so as to give them Lightness and Strength.*

Dated June 17, 1800.

WITH A PLATE.

TO all to whom these presents shall come, &c. Now know ye, that in compliance with the said proviso, I the said George Smart do hereby declare, that my said invention of a new application of tubical framed timbers for masts, yards, bowsprits, and other hollow timbers, where

 strength

ſtrength and lightneſs are wanted, is deſcribed in the following drawings and deſcription thereof; in witneſs whereof, &c.

Description of the Drawings.

(See Plate II.)

Fig. 1, A, the ſection of a ſmall tree, or ſpire, cut into four quarters, to form the corners or the framing-pieces morticed to receive the rails Fig. 2, B, which are tennanted to fit the mortices tight; the rails ought to be well ſeaſoned, and drove hard into the grooves of the covering-planks Figs. 3 and 4, C C, ſo as to truſs them tight, and at diſtances from each other according to the thickneſs of the outſide planking; and, when one plank in width fills one ſide, they are to be joined lengthways with a ſcarf or heading joint, and with a tube or hoops fitted tight and fluſh with the ſurface of the planking, as at H, Fig. 4. But, if two or more planks are wanted in width to fill one ſide, they may be bolted or pinned together, as at I, fig. 12: obſerving to ſhift the end-joints of the planks the diſtance of three or four rails from each other, and the joints to be over the rails and under the hoops which bind all together. G, is a tube to fit the corner-pieces A, to join them lengthways either by a ſcarf, or heading-joint. C, Fig. 3, is a view of the inſide of the planking with the rails in the grooves. H, a view of the edge of the planking C, with the depth of the grooves, and the thickneſs of one rail in the bottom groove.

A, Fig. 5, is a view of one of the corner-pieces, with the mortices to receive the rails B. The corner-pieces, or planking, to be cut from ſquare or round timber, as beſt ſuits the ſhape of the figure

figure to be framed. D, Fig. 6, is a section of a round mast. Fig. 7, is a part of a mast covered with the planks and hoops, and part without the planks. Fig. 8, is a section framed from small timber, curved on the side sufficient for the hoops to bind, and may be much lighter in the planking, and equally strong; as a greater number of the fibres of the wood on a square take the strain equally, and resist on the opposite side more regularly, than those of a circle; or, to make it still lighter, by framing the rails flush with the corner-pieces, and, to form the curve intended, one plank in width to be halved tight into the rails, leaving openings on each side of the planks, so that the masts, &c. may not hold more wind than a a solid mast of one half the diameter. By the above plans, the top mast slides into the lower mast, and the top gallant mast into the top mast. Fig. 9, is a section with a spindle in the centre with eight sides, which is morticed to receive planks. Fig. 9, K and L, is the outside planking, fayed into each other on the edges. Fig. 10, is a section of planks only fayed on the edges, and hooped. Fig. 11, is a section with braces fitted opposite to each hoop, and halved into each other so as to prevent the mast from wringing; but Figs. 6, 8, and 11, are the best, and so simple, that any carpenter with planks and spars might make masts, &c. of any dimensions.

Observations by the Patentee on the Strength of Timber, &c.

After spending much time in making various experiments, and comparing the results with those

of Buffon, Belidore, &c. the differences were so great, that it would be wasting time to enumerate them: I shall therefore only mention some useful observations necessary to be known by all those mechanics who use timber: and point out some evident errors in a table of Belidores, supposed to be the result of the best set of experiments ever produced in transverse strains. He tells us, "that "a bar of wood, 36 inches long, and one inch "square, supported at the ends by two props, "will break with a weight of 187 pounds on the "middle, if it is loose at the ends; but, if the "ends are firmly fixed, it will require 283 pounds "to break it." This appeared to me so great an error, that I was induced to put little or no confidence in many of his experiments; and, in consequence, I made two laths of fir, of the same dimensions, one with a strong shoulder at each end, to prevent its bending, which having firmly fixed in a frame, it carried a weight more than ten times greater than that which was loose: these experiments were made in the presence of Dr. James Anderson, and comparing them with the above statement of Belidore, prove him in an error, which can only be accounted for by his not having fastened the ends properly—a matter difficult to accomplish, as wood, though ever so much compressed, will slide, if not prevented by a shoulder opposed to the strain.

The fibres of timber requiring so great a force to tear them asunder in a vertical direction, and being so easily broken by a transverse strain, when compared to that of a rope carrying nearly an equal weight in all directions, opens a wide field for useful experiments.

I shall

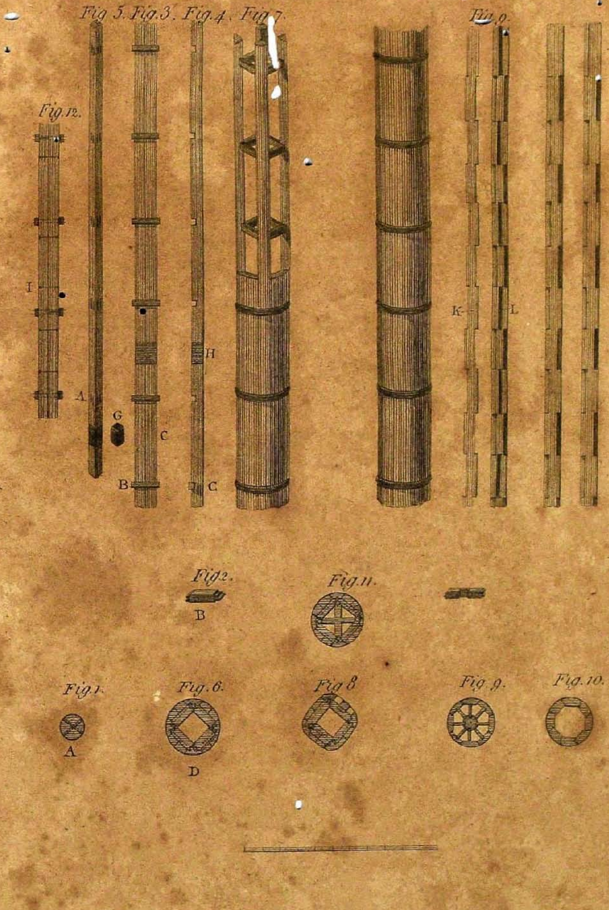
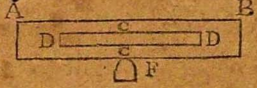


Fig 5.
Fig.3.
Fig.4.
Fig.7.
Fig.12.
Fig.0.
I
A
G
C
B
H
C
K
L
Fig.2.
B
Fig.11.
Fig.1.
A
Fig.6.
D
Fig.8
Fig.9.
Fig.10.

I ſhall here trouble the reader with a few obſervations, which I believe will be found new; and probably uſeful to thoſe who are in the habits of conſtructing machines, buildings, &c. as the knowledge of timber fit for different purpoſes is of the greateſt importance, though not generally attended to. All timbers have their annual circles or growths, which vary greatly according to the ſoil and expoſure to the ſun; which, in ſome degree, accounts for the great variation in experiments. The north-eaſt ſide of the trees (being much ſmaller in the grain than the other parts which are more expoſed to the ſun) is the ſtrongeſt for any column, &c. that has a weight to ſupport in a vertical direction; becauſe its hard circles, or tubes, are nearer each other, and the area contains a greater quantity of them; nor are they ſo liable to be compreſſed by the weight, or ſlide paſt each other, as when they are at a greater diſtance. On the other hand, this part of the tree is not fit for a tranſverſe ſtrain; becauſe the nearer the hard circles are to each other, the eaſier the beam will break; there being ſo little ſpace between them, the one forms a fulcrum to break the other upon: but that part of a tree, whoſe tubes are at a greater diſtance, or of larger grain, is more elaſtic, and requires a greater force to break it; becauſe the outſide fibre on the convex ſide, cannot ſnap till the next one is preſſed upon it, which forms the fulcrum to break it on. To prove this by a ſimple experiment, take a bar of wood, and cut a mortice through it as at DD, Fig. 1. Let AB be the length, DD the mortice, *cc* the centre, F the fulcrum; apply the weights at AB, and you

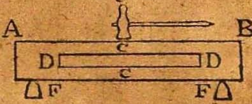
Fig. 1.



will

will find that the fibres of the wood at the upper *c*, will not ſnap till the under *c* is forced up thereto by the fulcrum F, otherwiſe the fibres at the upper c muſt be torn aſunder, or the fracture take place oppoſite DD: or take the ſame piece of wood, ſupported by a prop at each end, as in Fig. 2, taking away the fulcrum F, and you may ſtrike with a hammer, with all your force, at the upper *c*, without affecting the under *c*; the blow being felt only in the centre of the upper *c*, and at the two ends where ſupported; but were the bar a ſolid piece, it would immediately break at the centre where it received the blow, owing to the ſhock being conducted from one fibre to another, till it reaches the outer one at the under *c*, which muſt break. This experiment alone is ſufficient to prove to the unprejudiced reader the ſuperior advantages of hollow timber, when expoſed to ſudden tranſverſe ſtrains or jerks.

Fig. 2.

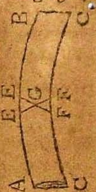


It is generally obſerved in large timbers, ſuch as maſts, &c. that the fracture is ſeldom on the convex, but uſually on the concave ſide, which is owing to the fibres on the concave ſide being more readily forced paſt each other, and thoſe on the convex being ſo difficult to be torn aſunder, as they cannot ſnap in conſequence of the largeneſs of the ſegment of the circle they deſcribe when on the ſtrain. The curve deſcribed by the inner layers of the wood being ſo large, and indeed little leſs than a ſtraight line, cannot form a fulcrum to break the outer ones upon; and as the convex ſide, or that on which the fibres are extended, ought to be always free from any mortice or inciſion on the outſide, (as it is the two oppo-

ſite

site outsides that have nearly the whole strain,) the strength decreases as it approaches the centre, as in Fig. 3, which represents part of a tree before the fracture takes place—AB the convex side, CC the concave side, EE the greatest extended fibres, FF the greatest compressed fibres, and G the centre, which is not extended or compressed by any agitated force whatever. From the foregoing observation I am of opinion, that in the construction of masts, or any other timbers that are exposed to a transverse strain, it would be always necessary to place the small fibres of the timber on the compressed side, and the large ones on the extended side.

Fig. 3.



Much timber, labour, and iron, might be saved in large buildings, if the principle of stiffning timber were better understood. A girder may be supported with a column, one quarter of the size now used, and equally strong, by cutting the girder about one third through on the upper side, opposite the centre of the column; and before the column is put in, raise the girder with a jack-screw, opposite the saw carf, as cambre, or as much curved as you please. The saw carf will form a proper opening for a wedge of hard wood, or hammered lead, the whole width of the girder, and may be trussed between the columns in the same manner. Girders of warehouses, &c. that are swagged or bent, may be raised by the above method without depending on the columns, which often have soft foundations, and will naturally sink when over loaded. Gutter-plates, and tie-beams, may be trussed as above, much superior to the common method, and not one-tenth part of the expence.

IV.

IV. *Specification of the Patent granted to* John Hotchkis, *Esquire, Lieutenant in his Majesty's Navy; for a new Mechanical Power for the Purpose of lifting Weights, moving Ships, weighing Anchors, &c.*

Dated October 3, 1799.

WITH A PLATE.

To all to whom these presents shall come, &c. Now know ye, that in compliance with the said proviso, I the said John Hotchkis do hereby declare, that my said invention is described in the above drawings and the following description thereof: The principle, upon which this new mechanical power acts, is that of a steel-yard with two arms, one of the arms consequently longer than the other, and bearing upon two, or more pivots, and worked by a lever or power in whatever way it may be applied to the steel-yard purchase; the weight which is to be lifted is made to bear upon both arms of the steel-yard by means of a rope, or chain, which is rove through a block, or pulley, so that the weight to be lifted is made to assist in lifting itself in the proportion which the short arm of the machine bears to the long arm; the difference of weight which is upon the long arm of the steel-yard, more than what is upon its short arm, is all the weight which bears on both arms, which the lever, or working power, by which this machine is moved, has to lift: therefore the nearer that the two arms are of the same length, the greater will the power be increased by this new mechanical principle; but,

but, if the two arms are made exactly of the ſame length, the machine becomes a balance, and is no longer a mechanical power, becauſe the weight ſuſpended to the block, or pulley, will gain nothing in height in turning the machine round. But, to demonſtrate how this new mechanical principle acts more clearly. Let A B, Fig. 1, (Plate III.) repreſent a line paſſing through the centre of a capſtan, or windlaſs, which revolves upon its pivots at A and at B, the diameter of whoſe larger barrel C D, is three feet, and the diameter of whoſe ſmaller barrel E F, is two feet; and let a rope, G, be put round the capſtan at D, and this end made faſt to this larger barrel, or held by men, the other end rove through the block, or pulley, I, and put round the ſmaller barrel of the capſtan at E, the contrary way to what it is upon the larger barrel of the capſtan; and alſo made faſt to it, or held by men. Now it is evident, that the weight which is attached to the block, or pulley, I, and ſuſpended over the roller K, bears upon the capſtan at E, in the proportion which the arm E H, on one ſide of the line paſſing through the centre, bears to the arm D L, on the oppoſite ſide of the line paſſing through the centre; that is to ſay, in a capſtan, or windlaſs of theſe dimenſions, E H, would bear a proportion of 0.4 of the weight ſuſpended to the block I, and D L would bear a proportion of 0.6 of the ſame weight; (viz. the weight at the block I) and ſuppoſe the weight attached to the block I to be 100 lbs. E H would bear 40 of theſe lbs. and D L would bear the remaining 60 of the 100 lbs.; now the 40 lbs. borne by E H, are not only taken off the 100 lbs. but, when the capſtan is hove upon by the lever, or working power, it is made to aſſiſt in lifting

 the

the 60 lbs. which bears upon the arm D L; but, as E H is ſhorter than D L, E H will require an additional proportion of weight, more than the difference of weight between the two arms; that is to ſay, E H would require .33, or $\frac{1}{3}$d more weight than D L to balance D L, becauſe E H is .33, or $\frac{1}{3}$d ſhorter than D L; now the .33, or $\frac{1}{3}$d of 60 lbs. is 20 lbs. which being added to the difference of weight between the two arms, the ſum of both weights will be 40 lbs. which 40 lbs. being attached to E H, and what farther weight was found neceſſary to overcome the friction on the machine, I ſay E H would balance D L, conſequently the 100 lbs. would be weighed; or the power is increaſed 2.5 times more than by the larger barrel worked by itſelf, and ſuppoſe the lever that this machine is worked by, is 10 feet long, the power will be increaſed in the whole.

Gained by the lever,	+6.60 times
Gained by the block the rope is rove through –	+6.60 Do. or it doubles.
The lever power	13.20
	2.5 ×
	6600
Gained by the ſmall barrel working againſt the larger 2.5	2640
The whole increaſe of power in this machine is	33.000

or

or 3.03 lbs. made to act upon the end of the lever, and what more was found necessary to overcome the friction would weigh the 100 lbs. suspended to the block; and it would gain in height, in one turn round of the capstan, half the difference of the circumferences of the two barrels of the capstan; that is, 1.5 feet.

As cranes and presses are machines which this new principle can be applied to with great effect, and as there is no occasion for the two barrels of the machine being in one piece, as was shewn in the capstan, or windlass, represented in Fig. 1., and in the explanations to that figure; and as much less room will be taken up by having the two barrels, or rollers, which compose the power by which this new mechanical principle acts, separate, but parallel each to each, and connected at one or both ends, and made to work against each other by the means of toothed wheels, cogs, or bands; a farther description of the principle acting upon the two barrels, or rollers, when separate, and shewing that both machines act upon the same mechanical principle, is here demonstrated. Let A B (see Fig. 2.) represent a line passing through the centre of a roller, whose diameter C D is 1.5 feet, and which revolves upon its pivots at A and at B; and let E F represent a line passing through the centre of another roller GH, whose diameter is 1.25 feet, and which revolves on its pivots at E and at F. The two rollers, parallel each to each, and connected to each other by means of the toothed wheels at both of their ends, the wheels of both rollers to be of the same diameters; and let one end of the rope I be put round the larger roller at C and D, and this end

made faſt to the roller; and let the other end of this rope I be rove through the block K, and put round the ſmaller roller at G and H, ſo as to make this roller pull the contrary way to the larger roller when there is any weight attached to the block K, and ſuſpended over the wheel N. Now it is evident, that the weight attached to the block K, bears upon G, in the proportion which the arm G L, in the ſmaller roller, bears in length to the arm C M in the larger roller, (that is to ſay) G L bears to the weight attached to the block K 0.4545 parts, and C M bears 0.5455 parts of the ſame weight, and ſuppoſe that weight to be 100 lbs. the arm G L would bear 45.45 lbs. and C M would bear the remainder of the 100 lbs. *viz.* 54.55 lbs.; now the weight borne by G L is not only taken off from the 100 lbs. but it is made to aſſiſt in lifting the 54.55 lbs. which bears upon C M; but, as the arm G L is ſhorter than the arm C M by $\frac{1}{6}$th part of the length, therefore there muſt be an additional weight of $\frac{1}{6}$th of the weight which bears upon C M more than the difference of the two weights between the arms, to make G L balance C M, (that is to ſay) that the difference of weight between the two arms, which is 9.1 lbs. and $\frac{1}{6}$th part of 54.55 lbs. which is 9.0916 lbs. the ſum of the two weights being 18.19 lbs. this additional weight with what is found neceſſary to overcome the friction, being attached to the arm G L, the two arms will balance, conſequently the 100 lbs. will be weighed, or the power would be increaſed 5.5 times; and ſuppoſe the lever which this machine is worked by to be 10 feet in length, the power altogether will be increaſed in theſe different proportions, *viz.*

By

By the lever — —	13.3 times.
Gained by the block which the rope is rove through	+ 13.3 ditto.
	26.6
Gained by the fmall barrel working againft the larger one	× 5.5
	1330
	1330
Whole increafe of power is	+ 146.30 times.

or 0.6836 of a lb. made to act upon the end of the lever, and what elfe was found neceffary to overcome the friction on the machine, the 100 lbs. attached to the block would be weighed, and would gain in height, in one turn round of the rollers, half the difference of the two circumferences of the two rollers, or .375 of a foot, therefore from what has been demonftrated, it is evident that a machine conftructed upon the plan of Fig. 2, acts upon the fame mechanical principle as a machine would do conftructed as Fig. 1. To fhew how this mechanical principle applies to preffes. Let A B in Fig. 3. reprefent the pifton of a prefs made to act upon this new mechanical principle. C D, a bar of iron, made to act upon the top of the pifton either horizontally or diagonally; and let there be two blocks, or pulleys, E, and F, at each end of the bar of iron, fitted fo as to traverfe along the bar; and let there be two rollers with toothed wheels, and worked by a lever (as reprefented by Fig. 2.) at G, with a rope or chain made faft to them, and paffing through the block at

at E; and let there be two rollers, the ſame as G, at H, with a rope or chain paſſing through the block at F, alſo worked by a lever; now it is evident, that whatever is below the piſton at B, when the new mechanical power is hove upon at G, and at H, that it will be preſſed according to the degree of power in theſe two machines; and it is alſo evident that the ſame mechanical principle acts upon this machine, as was ſhewn to act upon the two machines repreſented by Figures 1 and 2. If the principles by which any, or all, of the ſix mechanical powers act on (for the explanation of which ſee Encyclopædia Britannica, under the article Mechanicks) either as ſingle powers, or as compound powers of each other, be compared with the principle by which this new mechanical principle acts on, it will be clearly ſeen that the principles which theſe ſix powers act on, or the compound of theſe powers, are different from the principle upon which this new power acts, for it will be found that none of theſe powers, either ſingle or compound, cauſe the weight which is to be lifted to aſſiſt in lifting itſelf, which has been demonſtrated, and ſhewn that this mechanical power acting upon this new principle has that property of cauſing the weight which is to be lifted to aſſiſt in lifting itſelf; therefore the patent does apply to all machines which have or uſe a power acting upon this new principle, whatever the machines may be, and by whatever power or force they are worked. In witneſs, &c.

Fig. 1.

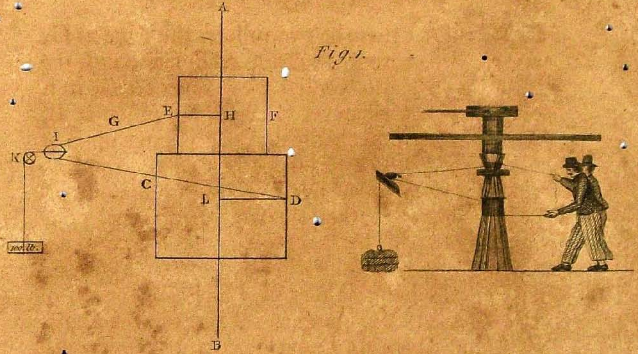


Fig. 2.

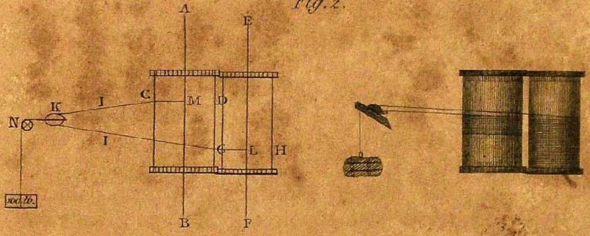
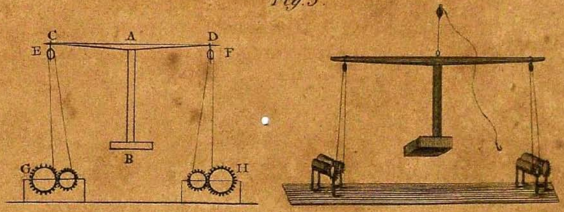


Fig. 3.



V. *On Clay and Marle. By Mr.* Josiah Rodwell, *of Liverpool, near Bury, Suffolk.*

From the Communications to the Board of Agriculture.

The Gold Medal of the Board was voted to Mr. Rodwell for this Communication.

Being informed that you have voted to an excellent farmer in Surrey, juſtly celebrated for his exertions, a mark of your approbation, it has been ſuggeſted to me by ſome neighbours, who have for twenty-eight years viewed what I have done to improve a poor and almoſt waſte tract of land, to ſend you an account of my operations, which I have complied with, truſting that this is the moſt likely method of inducing others to examine well their ſoils, and whatever may be found beneath: my practice is confined and limited, but your attention can ſpread any knowledge throughout the kingdom, and render the exertions of an individual beneficial to a whole nation.

I wiſh, at preſent, to call your notice to the effect of digging and ſpreading marle and clay upon poor dry heaths producing fern and gorſe, but chiefly ling; originally of ſmall value, at beſt yielding but a ſcanty ſupport to ill-fed ſheep.

The Rev. Mr. Lathbury's father, about fifty years ago, was offered any quantity of this heath at 4*d. per* acre: the farm on which I have been working

working consists of 1400 acres, 700 of which were of this sort of heath; it had been occupied by my predecessor, Mr. Garnham, for thirty-six years, at the rent of 140 *l.* and never more than 150 *l.* the landlord (Bapt. Lee, Esq.) paying tithe; nor did Mr. Garnham at that rent do much more than make a living in it. In 1771 it was valued for raising the rent, and 350 *l.* a year demanded, not tithe-free, at which rent Mr. Garnham refused it, as did several other farmers, who examined the land; and when I engaged at that rent I was pronounced a ruined man by most of my acquaintance who knew the farm. I had a lease of thirteen years.

My operations at first were to inclose with thorn hedges, marle or clay, and break up 300 acres of the heath; and in the first seven years of the lease I finished what I meant to improve in that term; I marled or clayed 600 acres, at 70 loads an acre, being 42,000 large tumbril loads. In this work I employed three teams, two of my own, and one I hired for several years. It is severe work; and the second year I lost nine horses, attributed to feeding on pea-straw from the new broken heath, a circumstance that deserves the attention of improvers.

In the eleventh year of my lease I applied to my landlord for a renewal; on which the farm was valued again by Mr. Hare, the surveyor at Peterborough, and I took a fresh lease of fifteen years, to commence at the termination of my old one, at the rent of 400 *l.*

I immediately clayed and broke up 200 acres more, at 100 loads an acre, 40 bushels *per* load, inclosing all with quick hedges, and ditches 5

 feet

feet wide, and 4 deep; after this, I improved 100 acres more in the fame manner.

In the two leafes of twenty-eight years, I clayed or marled 820 acres; and I have clayed or marled fo much over the fecond time, at 70 loads an acre, that the quantity I have carried in all is very little fhort of 140,000 loads.

Upon taking a third leafe, I was, in 1798–9, particularly fteady to this work, and, in forty-nine weeks and three days, carried 11,275 cubical yards, paying by meafure of pits, and not by loads, which were filled and fpread by four men and a boy, and carted by fix horfes and two tumbrils.

In this bufinefs of carrying clay or marle I have practifed hand-barrowing; the men can make good earnings at 10 *d.* a yard, wheeling it thirty rod; and down to 7 *d.* a yard at fhorter diftances; and I am much inclined to think, that if we had workmen ufed to the operation, and handy at it, like thofe employed in navigations, that this method would be of all others the cheapeft, efpecially on heavier foils. But by far the greateft part I have done by tumbrils, the expence of which put out is 5 *d.* a yard for team, and 2¼ *d.* a yard for labour, and paying for laying picks, wedges, &c. alfo for ftones that rife, increafe the whole expence to 8 *d. per* yard, which is at leaft ½ *d. per* yard cheaper than I can do it with my own teams: the reafon of which is, that the man who contracts with me drives his own horfes, and looks after them; at 8½ *d. per* yard, 140,000 yards have coft me 4958 *l.* excepting the fmall proportion *hired* at ½ *d.* a yard lower.

I come now to mention a few circumftances which I hope may tend to render this paper ufe-

 ful

ful to others, not having the experience which I have acquired: I ſhall uſe but few words, but they ſhall be founded on poſitive experiment, or attentive obſervation.

Clay is much to be preferred to marle on theſe ſandy ſoils, ſome of which are looſe, poor, and even a black ſand. By clay is to be underſtood a grey clayey loam, ſome of it brick-earth, and all has with vinegar a ſmall effervefcence. Marle is a white, greaſy, chalky, ſubſtance, that effervefces ſtrongly with acids: I make a univerſal rule, on a ſecond improvement, to lay clay on the fields marled before, ſometimes marle where clay was ſpread before; but this not general, as clay anſwers beſt on the whole.

In the tillage of improved lands, I am attentive never to over-crop. My uſual rotation has been,

1. Turnips.
2. Barley.
3. Clover, rye-graſs, and trefoil, one or two years.
4. Peas.
5. Wheat.

On ſome I have ſown oats on the layer, and omitted peas and wheat, which is more favourable to the land; and I ſhould with longer leaſes have done more ſo. Peas, it is true, are an improving crop, but the two coming together are perhaps working the marle too quickly. I have broken ſome heaths up and ſown oats, and even wheat, deſigning to improve on the ſtubble; but ſowing four buſhels of oats I have gained but ten, and of wheat not more than three coombs * at firſt breaking.

* The coomb is ½ a quarter.

My

My crops, by managing attentively, have been good; I have had 11½ coombs of barley an acre, and even 14, and these over large fields; I have had seven coombs an acre of peas over six score acres, and fine wheat after them.

On 90 acres, clayed 100 loads an acre, I have had after two crops, the one turnips, the other barley, close-feed, and fold it on the ground for 1000 guineas; then turnips, a famous crop, followed by barley, on 75 acres, 16 coombs an acre; and by oats on 15 acres (poorer land) 10 coombs an acre. These crops are for the soil *great*; but in general my products have been highly to my satisfaction.

In regard to other manures, my farm has had the fold of from 40 to 48 score sheep; they manure, one year with another, 150 acres; and I am never without bullocks for increasing the farm-yard dung. I top fold wheat from the beginning of November till Christmas, and even till February, and venture it on clayed land at the hazards of frosts at sun-rise, which sometimes injures it much, but the effect in general is great. Of all mucking, that for turnips pays me best, particularly on clayed land: I know many farmers in Norfolk prefer laying it on for wheat, the turnips to have it at second; but I prefer the other method. And let me note, that I use long muck to choose, which I think far better than turning, mixing, and rotting muck; here also are different opinions; I speak only from my own experience. Wheat stubble, I think, should always be whelmed in for turnips.

I once ploughed in a fine crop of buck-wheat for turnips, and the crop was so much worse than the rest of the field, that they were not penned

regularly for the ſheep; yet, with this diſadvantage, the barley, following was better than where the turnips were much ſuperior.

I have dibbled largely, and with good ſucceſs, and think it the beſt method; and I approve much of the drill roller as the next beſt.

In tilling theſe improved ſands, it is a common obſervation in Norfolk, that ſhallow ploughing is neceſſary to preſerve *the pan**: I have not found this the caſe here; but, on the contrary, that the clay and marle works the better the more ſoil it has to incorporate with.

Having thus ſtated, ſhortly, the general managements of my improvements, I now come, with your permiſſion, to the general reſult. Rent will ſpeak this:

It is ſtated, that, twenty-eight years ago, the rent of farm was 150 *l.* a year, tithe free, and that it was then raiſed to 350 *l.* a year, tithe payable. I may venture to aſſert, that, at that rent, without improvement, it might have ſo ſtood on my landlord's rent-roll till doomſday, for a mere living could only be made on it even in good times. But upon my taking the third leaſe, commencing 1799, it was raiſed to 600 *l.* a year, at the ſame time that to the full value of 100 *l.* a year was taken from it; in other words, the preſent rent is 700 *l.* a year. Thus, while, with the bleſſing of God, I have done well in the farm, and have put five children into the world out of twelve living, I have added 350 *l.* a year to the value of the eſtate, which, at thirty years purchaſe, is 10,500 *l.*; and, relative to the public at large, I may venture to aſſert, that theſe 1400 acres have, in the laſt twenty-eight years, yielded 30,000 *l.* worth more of corn, meat, and wool, than

than they did in the twenty-eight preceding. A fact which tends strongly to shew the national importance of improvements in agriculture, and also the wisdom of establishing a public board for promoting and encouraging such exertions as may be deemed laudable.

VI. *Account of some interesting Experiments on the various Modes of raising Turnips.*

By Mr. W. Jobson.

From the Communications to the Board of Agriculture.

THE paper I herewith inclose contains the weight of six parcels of turnips, which were part of a field of fifteen acres, sown in the month of June, 1797, for the purpose of ascertaining the comparative value between the drilled and broad-cast method. The whole field was in equal tilth, was manured as equally as possible, immediately before sowing, with rotted fold-yard dung, at the rate of seventeen cart loads *per* acre, each load containing about twenty-eight Winchester bushels; and, in order to make the experiment perfectly fair, there were breadths of land of twenty yards each, sown in broad-cast and drills alternately, throughout the whole field; part of the drills on one-bout ridges of twenty-seven inches each, with the dung laid immediately underneath, where the row of seed was deposited; the rest of the drills upon

upon a level ſurface, were ſown by Mr. Bailey's machine, at twenty-one inches diſtance. The produce *per* acre is calculated from the weight of four ſquare perches, or the fortieth part of a ſtatute acre of each, having firſt cut off the tails, or fibrous part of the root, and thrown them aſide, as unfit for food, and then taken the weight of the tops and roots ſeparately.

It is neceſſary to obſerve, that this field of turnips was but a middling crop, having been much hurt, immediately after the firſt hoeing, by the grub (a ſmall worm which deſtroys the tap root); particularly the drilled part of the field, which, having had the plants ſet out, at the diſtances at which they were intended to remain, before the grub ſeized them, was on that account rendered too thin, and otherwiſe much injured; notwithſtanding which, it was found that thoſe on the one-boot ridges exceeded the others in weight: alſo, that theſe parcels of turnips were taken from an inferior, (though not the worſt part of the field,) and may therefore be deemed to be a pretty fair average of the whole: there were alſo three other portions weighed which were taken from a part of the field where the roots were larger, and a fuller crop, with a view to aſcertain what might have been expected, had not the grub ſeized them in the manner deſcribed; but, unfortunately, the paper containing their weight has been loſt or miſlaid, which puts it out of my power to furniſh you with it. There was alſo an account taken of the number (but not the weight) of loads which were produced upon a few acres of the worſt part of the field, which was in favour of the broad-caſt, in the proportion of ten of broad-caſt to nine of

thoſe

those drills on one-bout ridges, and eight of Mr. Bailey's drill.

From this experiment (though defective from the reason assigned) we have reason to conjecture, though not to form a conclusion, that a heavier crop *may* be raised by sowing in drills, at twenty-seven inches distance, with the dung immediately beneath the plants, than in broad-cast, or in drills at twenty-one inches on a level surface; but whether the advantage arises from the situation in which the dung is deposited, or from their having a freer circulation of air, or from both these united, it remains for future and repeated experiments to decide. Notwithstanding this, it will be found that each of these methods possess peculiar advantages and disadvantages, according to situations and circumstances; the reasons for which I deduce from the observation I have made respecting this, as well as former crops. In the first place, the one-bout ridges I think preferable for early sowing, and eating off, through the winter months, even so late as the month of February, as they are more easily procured for food for cattle in deep snows; also in situations where it is difficult to procure a sufficient number of experienced hoers. Those under the drill-system can be more easily managed, and at less expence, as boys and girls may be readily taught to set out the plants with great regularity in very little time; but turnips, under this system, are liable to the inconvenience of being more apt to be injured by severe frosts, from their high exposure. Another inconvenience I have also observed on wet and heavy lands, more especially with little declivity, that although there should,

ſhould, and poſſibly may, be a larger crop produced thereby, yet the land will unavoidably be ſo much poached by carrying them off, that the ſucceeding crop of corn may be leſſened more than the extra value of the turnips will compenſate. When it is attempted to raiſe turnips upon land of this deſcription, it will be found more advantageous to form it into ridges of ſufficient height, to carry off the water with eaſe into the water furrows, and of ſufficient breadth (ſuppoſe fifteen feet) to allow a cart to paſs along them freely, without forcing the earth in, to choke up theſe furrows. The turnips may be ſown either broad-caſt, or in drills, upon the ſurface of theſe ridges. If the land is addicted to annual weeds, they will be beſt in drills, which will expedite the hoeing; but if not, or if they be late in ſowing, or if the land be ſubject to the grub, broad-caſt will generally be found to produce a more certain crop, as they can be left ſo near to each other at the firſt hoeing, as to admit of being thinned, and thereby gives the opportunity of taking out unhealthy plants at the ſubſequent hoeings; and alſo, that they grow more vigourouſly between the firſt and ſecond hoeings; which I attribute partly to the broad-caſt plants ſheltering each other more, and partly to the earth being ſo much looſened near the plants in the drills, when they are cleaned by the plough or horſe hoe, before the tap root has got a ſufficient hold to ſupport them.

Comparative

Comparative Weight of fix Portions of Turnips, which were Part of a Field of fifteen Acres, at Turvelaws; the Whole of which was fown in the Month of June, 1797, as an Experiment between the Drill and Broad-caft Syftems.

	Time of weighing.	No. upon 4 fquare perches.	Weight on 4 fquare perches, or 40th part of an acre.						Weight per ftatute acre.				Average weight of each turnip.		Average diftance of each turnip.
			Roots.			Tops.									
			cwt.	qr.	lb.	cwt.	qr.	lb.	tons.	cwt.	qr.	lb.	lb.	oz.	
No. 1. Drilled on one-bout ridges, at 27 inches diftance, -	January	354	8	1	1	1	1	3	19	1	0	20	3	$0\frac{1}{4}$	$16\frac{1}{2}$ in. by 27 in.
2. Drilled with Mr. Bailey's machine on a level furface, at 21 inches diftance, -	ditto	428	7	1	$15\frac{1}{4}$	1	1	$5\frac{1}{4}$	17	7	1	8	2	$4\frac{1}{4}$	17 in. by 21.
3. Broad-caft, - -	ditto	568	7	2	$12\frac{1}{2}$	1	0	$11\frac{1}{4}$	17	8	1	26	1	$11\frac{1}{2}$	$16\frac{1}{4}$ each way.
4. Drilled on one-bout ridges, at 27 inches diftance,	March 2d.	334	8	3	0	1	1	22	20	7	3	12	3	$6\frac{1}{2}$	17 by 27.
5. Broad-caft (thefe and the preceding were round white turnips), - -	ditto	628	8	2	22	1	1	8	20	0	2	24	1	$12\frac{1}{2}$	16 each way.
6. Broad-caft (red), -	ditto	561	6	3	$26\frac{1}{2}$	2	3	5	19	11	1	0	1	$15\frac{3}{4}$	$16\frac{1}{2}$ ditto.

By noting the average diftance of each turnip, as is done in the laft column, is intended to fhew at one view how many plants there were wanting in the drills to have made them a full crop; for, if 550 be ftated as a medium number in a full crop, upon the 40th part of an acre, they will be found to occupy a fpace of 17 inches each way in broad-caft, $10\frac{1}{2}$ by 27 inches on the one-bout ridges, and $13\frac{1}{2}$ by 21 inches of thofe drilled on the level furface; from whence may be eafily feen how much thofe were wider in the rows than they ought to have been.

VII. *An Enquiry concerning Tin. By* M. PROUST, *Professor of Chemistry at Madrid.*

FROM THE *JOURNAL DE PHYSIQUE.*

PELLETIER has already shewn, that tin is susceptible of combination with two different proportions of oxygen; and that, in these two different species of oxydation, it exhibits various phænomena hitherto but little known. What I am about to offer in the present essay may be considered as a supplement to the researches of that celebrated chemist, whose loss France now so justly deplores.

I. Nitric acid of fifteen degrees dissolves tin easily, without effervescence, and with an extrication of heat, which it is proper to check, by plunging the vessel into cold water, in order that the acid may be prevented from producing those very different effects, which result from a solution made with the application of heat. During this process, the tin crumbles down into a black powder. This powder, or solution of tin, is not formed at the expence of the acid alone; for this, as we shall see hereafter, contributes to the formation of only a very small portion of it; but, on the contrary, the agent by which this species of solution is effected is almost entirely furnished by the decomposition of the water.

This solution, when filtrated, is of a yellow colour: in the course of twenty-four hours, it becomes turbid, and deposits a quantity of oxyd. On heating it, the deposit becomes more abundant; but this separation does not result from any reaction

action of the acid, as it is attended with no extrication of nitrous gas. It contains a ſmall quantity of ammoniac, which may readily be diſcovered, by adding an exceſſive proportion of vegetable alkali: the oxyd then diſſolves, and the ammoniac becomes immediately perceptible to the ſenſes; the oxyd, whether ſeparated ſpontaneouſly, or by the operation of heat, differing in no reſpect from that diſſolved in the nitrous acid. In the firſt place, this ſolution decompoſes corroſive ſublimate and the oxyd of mercury, by depriving them of their oxygen; ſecondly, the oxyd ſeparated ſpontaneouſly, and diſſolved in muriatic acid, deprives them likewiſe of that principle, ſo that there is no difference between the oxyd depoſited, and that retained by the nitric acid. If the oxyd has a tendency to ſeparate itſelf from the nitric acid, it is becauſe this acid is, in general, a bad diſſolvent of the oxyds of tin. But the conſequence deducible from theſe facts is, that weak nitric acid, in diſſolving tin, oxydates it only to the loweſt point of ſaturation, namely, that in which this metal exiſts in the common muriate of tin, or any other ſolution which poſſeſſes the power of diſoxygenating the oxyds of mercury; and, finally, the production of ammoniac, which reſults from the azote of the nitric acid becoming fixed by combination with the hydrogene of the water, indicates the cauſe, why this ſpecies of ſolution is performed without any extrication of aëriform fluids.

If we heat this ſolution with the admixture of a ſmall quantity of nitric acid, nitrous gas will be diſengaged in abundance. The metal, being oxydated to the higheſt point of ſaturation, relinquiſhes the acid, and the reſulting phænomena

fall into the clafs of thofe belonging to the folutions which are next to be treated of.

II. It is well known, that an acid from twenty-five to thirty degrees converts tin into a white oxyd, the liquid retaining not a particle of the oxyd in folution; for, were this the cafe, it would immediately be precipitated in the form of yellow oxyd, by an admixture of hepatic water; but, if the tin contained any lead or copper mixed with it, thefe metals would be feparated in the ftate of black fulphurets—the copper firft, and afterwards the lead, conformably to the different degrees of force with which thofe metals retain oxygene.

Let us fuppofe, for example, we have a folution in nitric acid of four metals—of lead, of copper, of zinc, and of iron. Add carefully a quantity of hepatic water to the folution—the fulphuret of copper will be firft precipitated. Filtrate, in order to feparate it; add a frefh quantity of hepatic water; and the fulphuret of lead will next be depofited, very different in colour from the fulphuret of copper. Filtrate a fecond time, and apply the fame re-agent to the liquid; the zinc will be feparated in the form of a yellow fulphuret, or artificial *blende*. The folution, being now deprived of the three firft metals, will retain only the iron, but with this difference, that, being oxydated to the higheft point of faturation by the former precipitation, it will have been reduced to the loweft, and may ftill be precipitated by ammoniac, lime, &c.

A lixivium with tin oxydated by nitric acid to the higheft point of faturation yields, by evaporation, nitrate of ammoniac,—not of tin, as has been formerly fuppofed.

Nitric

Nitric acid, which, compared with water, is as 148 to 100, does not attack tin, even though the metal ſhould be reduced to a fine powder.

Arſenicated Hydrogene.

III. The hydrogene, which is extricated from a ſolution of tin in muriatic acid, has an offenſive ſmell, and frequently contains a quantity of arſenic. If we ſet fire to it, it depoſits this metal on the ſides of the veſſel. This gas is very detrimental to the luſtre of the purples of Caſſius. It is neceſſary that the muriate ſhould be heated, in order to diſſipate whatever remains of the gas, if we wiſh to obtain purples of a rich colour.

Muriatic acid is very capable of ſeparating arſenic from tin; but in order to appreciate its quantity, it is neceſſary to take into the account that which the hydrogene carries off with it.

In order to procure this gas in abundance, and with greater facility than can be done according to Scheele's method, nothing more is requiſite than to mix the powder of white arſenic with zinc and ſulphuric acid. The extrication is here leſs abundant than when we employ zinc alone; for a part of the hydrogene is expended in converting the oxygene of the arſenic into water. In the courſe of a few days it depoſits a portion of its arſenic; but it ſtill retains a conſiderable quantity of it even for a ſpace of two years. If we mix it with atmoſpherical air, and ſet fire to it, a part of the arſenic will be converted into white oxyd; and with a ſufficient proportion of oxygene gas it may be changed into arſenical acid.

If

If we bring into contact the mouths of two bell-glasses, of the same dimensions, the one filled with arsenicated hydrogene, and the other with oxygenated muriatic acid, combustion takes place, and muriate of arsenic, &c. are formed.

This combustion tends to separate the two bell-glasses from each other, but it is not otherwise attended with any danger.

Having treated of arsenicated hydrogene, I am naturally induced to say a few words concerning sulphurated hydrogene; after which I shall resume my observations on the muriate of tin.

If we wish to procure this gas well saturated with sulphur, we ought to pour a small quantity of sulphuret of potash into the flask which contains the acid and the sulphuret of iron. The sulphur, which is precipitated, unites more easily with the hydrogene, and increases its weight to that degree, that if it be kept in an open bell-glass, with its mouth turned upwards, we are sure to find it still remaining there, without diminution, at the end of half a quarter of an hour.

Action of the Muriate of Tin upon the Solution of Iron.

IV. A few drops of the muriate of tin, poured into the yellow muriatic acid, whiten it instantaneously; for the tin deprives the iron of that quantity of oxygene upon which the difference between the red and the green oxyd depends. The same change takes place with the red sulphates, nitrates, and muriates of iron. All these solutions are reduced to that state, in which they form a green precipitate with ammoniac, &c.

But

But if we pour a larger quantity of the muriate into the yellow acid of commerce, this becomes turbid and of a greyiſh colour, depoſiting mercury in the form of a powder, as I have ſhewn in a former memoir.

Concentration of the Muriate of Tin.

V. It has been ſuppoſed, that, by means of diſtillation, this muriate might be brought to the ſtate of a fuming liquid. I ſhall relate the phænomena which take place in the diſtillation of a muriate made with acids which contain ſulphuric, and frequently alſo ſulphurous acid.

The water riſes firſt, and afterwards the acid mixed with a ſmall quantity of tin; the muriate bubbles up whilſt it is loſing the laſt portions of humidity, and at length remains tranquil in a ſtate of fuſion.

In order to effect the diſtillation, it is neceſſary to heat the retort to a ſlight incandeſcence, and to give it as much inclination as is requiſite for preventing the obſtruction of the neck and the rupture of the veſſel. From time to time ſome puffs of fuming vapour, produced by the ebullition, paſs over into the receiver, but no liquid; and the whole of the product is in a concrete ſtate.

In this diſtillation, the ſulphuric acid is decompoſed, and the reſults are as follows. The ſulphur deprived of oxygen unites with the oxyd of tin, and forms a reddiſh ſubſtance, which colours the muriate in the retort. By ſolution and filtration we may ſeparate this ſubſtance, which is nothing more than the brown ſulphuret of tin, namely that which is furniſhed by the

muriate,

muriate, and every ſolution of tin, in which the oxyd is at the loweſt point of ſaturation,

When the muriate has been ſeparated from this ſulphuret, it depoſits a part of its oxyd; but by adding a few drops of muriatic acid the ſolution is re-eſtabliſhed. If we continue the diſtillation, it riſes in a concrete form, leaving nothing at the bottom of the retort, except a ſmall quantity of oxyd, which has become fixed for want of acid.

Such is the manner of treating the ſimple muriate of tin: it requires for its ſolution an infinitely greater degree of heat, than the fuming muriate, which, on the contrary, is ſenſible to the ſlighteſt action of the fire.

The diſtilled muriate of tin has undergone no ſort of alteration: it is an efficacious decomponent of corroſive ſublimate and all other mercurial preparations.

That ſubſtance which condenſes itſelf in the neck of the retort, after the extraction of the fuming muriate, is nothing more than a ſemi-oxydated muriate of tin. It decompoſes corroſive ſublimate and the mercurial oxyds, though the fuming muriate, the oxyd of which is at the higheſt point of ſaturation, poſſeſſes none of theſe properties.

VI. The muriate of tin, when treated with the alkalies, yields a precipitate, which, like that of antimony and others, is not ſuſceptible of converting itſelf into a carbonate. The cauſtic vegetable alkali diſſolves it eaſily and in abundance. If we keep this ſolution well corked up in a flaſk, we find, at the end of twelve days or a fortnight, a collection of metallic particles diſpoſed in the form of a colliflower, which is nothing elſe than pure tin. If we wiſh to learn the principles upon which

which this ſingular reduction depends, we muſt examine the ſtate of oxydation in which the tin exiſts in its ſolution with the potaſh, and for that purpoſe precipitate, lixiviate, and diſſolve, this oxyd with muriatic acid. This new ſolution has no longer the power of decompoſing corroſive ſublimate; whence we may conclude, that one part of the oxyd has been ſaturated, at the expence of the other, with oxygen, with which tin has ſo ſtrong a tendency to unite. In treating of the different degrees of the oxydation of mercury, I ſhall have occaſion to mention an inſtance of the like ſpecies of diſoxygenation.

The following is a fact pretty nearly of the ſame kind. If we keep under water, in a well-corked flaſk, a mixture of carbonate of copper and oxyd of tin, ſeparated from the muriate by means of potaſh, the copper loſes its carbonic acid and oxygene, and is found in cryſtallized metallic flakes among the oxyd of tin.

Finally, the muriate of tin diſoxygenates indigo, changing it into a green powder. This fact is analogous to ſeveral other diſoxygenations of indigo well known in the art of dyeing: nevertheleſs the ſubject ſeems to me well to deſerve being farther purſued, with a view to throw ſome light upon the nature of a ſubſtance, which, it would be very deſirable, we might be able to extract or compound from ſome of our own indigenous plants. But for this purpoſe it would be neceſſary that we ſhould make our experiments upon indigos lixiviated with water, with alcohol, and even with weak acids, which ſeparate from it magneſia and chalk.

Of the Action of the Muriate of Tin on the Combinations of Copper.

VII. The sulphate, the nitrate, the muriate, the acetite, the carbonate of copper, the red, black, blue, and green oxydes, when mixed with muriate of tin, are generally converted into a white powder which collects at the bottom of the vessel.

When we have separated the muriate from this powder, we ought to pour it upon a fresh quantity of oxyd chosen for the purpose, in order that we may take advantage of its disoxydating power, and thus procure as much of the white powder as it is able to furnish. We may easily perceive when the muriate begins to be saturated with oxygen, by the portions of the oxyd (I prefer the carbonates,) which it is no longer able to deprive of their colour, as well as by the greenish tinge which it assumes itself.

As this powder is little soluble in water, it is easy to separate it from the muriate of tin by lixiviation: if we employ boiling water, a partial decomposition of the powder is effected. On the side exposed to the light, it acquires a dull violet colour, which by the action of the direct rays of the sun is changed into a blackish blue. If, after drying it, we leave it exposed to the atmosphere, it gradually changes into a beautiful green powder, which attracts moisture, without however deliquescing.

Subjected to the action of the fire, in a retort, it gives out water, melts easily, and sustains the heat without undergoing any change of composition. When taken out of the retort, it appears in

in the form of a greyiſh-white maſs, tranſparent in various parts, and much reſembling muriate of ſilver recently melted.

As fuſion augments the denſity of this ſubſtance it ought rather to be kept in that ſtate, than in the ſtate of powder. But, when by having been expoſed to the atmoſphere it begins to turn green, it may be reſtored to its former ſtate by lixiviation, either with muriate of tin, or ſulphuric acid much diluted. The firſt deprives it of the oxygen which had begun to colour it, and the ſecond diſſolves the green cruſt, without affecting the white part of the maſs.

VIII. Diluted ſulphuric acid digeſted upon this ſubſtance, whether with or without the application of heat, does not diſſolve any part of it; and, if it be kept with this acid in a flaſk well corked, it ſuffers no alteration. The muriatic acid diſſolves it without the application of heat, forming a colourleſs ſolution, which water immediately decompoſes. This ſaturated ſolution depoſits white cryſtals, about a line in length, and conſtantly of a tetrahedral form.

The nitric acid attacks this ſubſtance very briſkly, exhibiting ſeveral very beautiful phenomena. It at firſt aſſumes a rich violet colour, which afterwards changes into a very beautiful blue. But the extrication of heat and of nitrous gas, and this ſucceſſion of colours, are produced in a ſingle moment, and the mixture is then nothing more than a ſolution of nitrate of copper, in which that of ſilver ſhews that it contains muriatic acid.

Theſe different phenomena are already ſufficient to point out to us the nature of this ſubſtance. The muriatic acid is here combined with

the copper, whilst the extrication of nitrous gas indicates, that the oxyd, which is the base of this muriate, is not oxydated to that degree, in which it was, before having been subjected to the action of the muriate of tin. That this is really the fact, we shall soon see confirmed by the analysis of the white muriate of copper. By reflecting on the absence of colour in this muriate, as well as upon its dissolution in ammoniac, I had been led to believe that oxygen did not exist in it; and that this com bination was an exception to the universality of that law so well demonstrated by Lavoisier, namely, that no metal can become united with the acids, without the intervention of oxygene; but I was soon undeceived by its analysis.

Analysis of the White Muriate of Copper.

IX. Dissolve 100 grains of fused white muriate in very pure nitric acid, and one grain of oxyd of tin will be separated. This solution may afterwards be precipitated by means of the nitrate of silver, and we shall constantly obtain 142 grains of muriate, which contain $24\frac{2}{3}$ of muriatic acid, according to the proportion established by my experiments of $23\frac{1}{2}$ grains of this acid contained in 133 grains of muriate of silver.

If, on the other hand, we treat 100 grains of white muriate with nitric acid and carbonate of potash, we obtain 113 grains of carbonate of copper; a quantity, which, according to my experiments, answers to $62\frac{7}{9}$ or 63 grains of copper. Thus we have three known products, which will lead us to the discovery of the fourth. These products are:

Muriatic

Muriatic acid - - -	$24\frac{2}{3}$
Oxyd of Tin - - -	1
Copper - - - -	63
Nothing more, therefore, is wanting to the formation of a quintal of the muriate in queſtion than,	
Oxygene - - - -	$11\frac{1}{3}$
	100

Hence it is evident that if we apply this proportion to the quintal of copper, this metal is oxydated only to $17\frac{2}{3}$ or 18 in our muriate, while in the green muriate, the nitrate, the ſulphate, the acetite, and the native oxyds, the copper is conſtantly oxydated with 25lbs. of oxygene in the quintal.

From theſe facts it appears, that when copper is oxydated in the proportion of only 18 *per cent.* it produces white combinations, and can neither colour its muriate nor its diſſolution in ammoniac.

The preſence of oxygene in this muriate is farther proved by the following fact. If, while it is in a ſtate of pulveriſation under the water, we add a ſmall quantity of iron-filings, the copper will be ſeparated, and the liquid contain muriate of iron oxydated to the loweſt point of ſaturation, or that in which it forms a green precipitate by the action of the alkalies.

X. I ſhall ſtill record a few more facts, which tend to illuſtrate the nature of this muriate. If we take a ſmall piece of ſuch as has been recently fuſed, and throw it into a flaſk filled with ammoniac, it diſſolves without communicating any colour to the liquid; but as ſoon as we uncork the flaſk, the ſurface of the ſolution acquires a

blue tinge, and gaining a greater degree of density, by means of the oxygene which it abſorbs, in proportion as it becomes more and more coloured, a beautiful blue precipitate is obſerved to deſcend, in the form of a net, from the ſurface to the bottom, till the whole of the liquid has been ſucceſſively expoſed to the contact of the air.

In like manner, if we pour a ſmall quantity of ammoniac into a glaſs filled with water, into which we have juſt before dropped a portion of the white muriatic ſolution, the white powder will be diſſolved, and the liquid, which before was colourleſs, will acquire a blue tinge by the abſorption of oxygene from the atmoſphere.

If we uncork a flaſk which contains a ſolution of the white muriate in marine acid, the liquid, at firſt, aſſumes a dirty greeniſh, or rather yellowiſh colour, and, in proceſs of time, becomes as green as a ſolution of copper oxydated at 25 *per cent.* But this colour and the precipitation in water, are qualities that cannot have eſcaped the notice of any one who has attempted to diſſolve copper in the marine acid.

If we only keep a plate of copper in a flaſk filled with marine acid, we ſhall find, after a certain period, the ſurface of the plate covered with white tetrahedral cryſtals, and the colourleſs acid will depoſit a white powder by admixture with water.

It cannot be doubted, as Berthollet has alſo obſerved, that copper treated with marine acid oxydates itſelf at the expence of the water: of this the following experiment will furniſh an additional proof. If we boil the blue ſulphuret of native or artificial copper in this acid, we obtain a ſolution which is precipitated by means of water; during which proceſs, the hydrogen becomes perceptible

ceptible to the ſmell, on account of the ſulphur with which it combines. Finally, it cannot be doubted, that copper, notwithſtanding the weakneſs of its affinity with oxygene, is capable of decompoſing water, aided eſpecially by the attraction which the acids exert upon theſe oxyds; but it remained to be ſhewn, that this metal follows the law which obtains with all thoſe, which, like iron, tin, &c. never become oxydated above the loweſt point of ſaturation when treated with muriatic acid. It is rather ſingular, that copper treated with this acid, does not become oxydated beyond the proportion of 18 *per cent.* though in verdegris, and the acetite, it is at 25; but we ſhould recollect, that, in the formation of verdegris, the oxygene, by which the oxydation is effected, is almoſt entirely furniſhed by the atmoſphere.

XI. If we diſtil a green muriate of copper, well ſaturated with oxyd, we eaſily bring it to the point of cryſtallization; but by puſhing the diſtillation farther, it is ſoon decompoſed; that is to ſay, that portion of oxygene which conſtitutes the difference between the oxyd at 25, and that at 18, relinquiſhes the metal to combine with the muriatic acid. Hence, the oxygenated muriatic gas which accompanies this diſtillation. By continuing the proceſs, this gas ſoon ceaſes to be extricated, and we find, at the bottom of the retort, a greyiſh maſs well fuſed; which is nothing more than the white muriate of copper. This is a ſecond method of procuring this ſpecies of muriate, which may be obtained even from the green ſand of Peru, and from the native muriate of copper found in Chili.

Of

Of the Oxyd, which forms the Base of the White Muriate.

As it ſeemed to me an intereſting enquiry, to conſider copper in its ſtate of ſemi-oxydation, I endeavoured to obtain it ſeparated from marine acid. Cauſtic pot-aſh produces a white precipitate from the ſolution of the white muriate in marine acid; but this precipitate is nothing elſe than the muriate itſelf: in order to decompoſe it, it is neceſſary to heat this precipitate with cauſtic pot-aſh; it then acquires a yellow, and afterwards a dirty yellowiſh colour, which very much reſembles that of pulveriſed glaſs of antimony. When this oxyd is kept under water, it acquires, by imperceptible degrees, a black colour at its ſurface; it atracts oxygene, which is, in fact, the cauſe of the black colour of copper oxydated to the higheſt point of ſaturation.

Water alone is able to effect a partial decompoſition of pulveriſed white muriate. On plunging this ſubſtance into a large quantity of boiling water, it becomes yellow, and, like the nephritic decoction of woods, preſents a variety of different colours, according to the ſituation in which it is placed between the eye and the light. This decompoſition is, in fact, only partial; for the yellow powder, when well waſhed, is ſtill found to contain a portion of the muriatic acid, the greater part of which has combined with the water, together with a ſmall quantity of oxyd, which it holds in ſolution. Theſe habitudes of the white muriate with water appertain equally to a great number of other metallic ſalts, ſuch as the nitrates and ſulphates of mercury, the nitre of biſmuth, &c.

TO BE CONCLUDED IN OUR NEXT.

VIII.

VIII. *Obſervations on the real Nature of Kali underſaturated with carbonic Acid (or common Kali). By Mr.* Lowitz.

From Crell's Chemical Annals.

THE repeated experiments which I have inſtituted in order to produce kali completely ſaturated with carbonic acid, without adding carbonic acid to it, have led me to an enquiry, which, in my opinion, is deſerving of ſome attention.

It is well known, that we obtain kali by the combuſtion of vegetable ſubſtances, uniformly and without exception, in a ſtate of imperfect ſaturation with carbonic acid. This ſtate of imperfect ſaturation was hitherto univerſally conſidered (at leaſt to the beſt of my knowledge) as merely an accidental circumſtance, or ſomething of the ſame kind as takes place when in artificially combining the conſtituent principles of a neutral ſalt, ſuch, for example, as ſaltpetre, glauber-ſalt, acetite of kali, &c. one or other of theſe principles was added in a proportion more than ſufficient for their neutralization, in which caſe the compounds were generally and indiſcriminately ſaid to be *ſuperſaturated*. That this, however, is not the caſe with the ſalt about which I am to treat, namely, the common kali, and that this ſalt owes its imperfect ſaturation to ſomething more than mere accident, I hope to demonſtrate by what I ſhall advance in the courſe of this eſſay.

The ſuperſaturation of a neutral ſalt with one or other of its component parts may be diſtin-

guiſhed into two ſpecies; namely, *mechanical* and *chemical* ſuperſaturation.

The firſt, namely, the mechanical ſuperſaturation, is to be conſidered merely as an accidental circumſtance; ſince that part, whether it be the acid or the alkali, which has been added in an over-proportion, may again be ſeparated from the neutral ſalt, even by mere cryſtallization, and drying the cryſtals with blotting paper, as alſo by alcohol, if, as is often the caſe, the neutral ſalt is not ſoluble in that liquid.

In the chemical ſuperſaturation, on the contrary, no ſuch ſeparation of the part exiſting in an over-proportion is practicable by any of the above-mentioned means, as here the acid and the alkali are in a ſtate of real chemical combination, and form a ſaline compound poſſeſſing properties peculiar to itſelf, and widely different from thoſe that appertain to the perfect neutral ſalt compoſed of the ſame acid and alkali, ſuch as its degree of ſolubility, the form of its cryſtals, &c. Of ſuch compounds we have very perfect ſpecimens in thoſe chemically ſuperſaturated ſalts with which we have hitherto become acquainted; for example, borax, tartar, the ſuperſaturated ſulphate of kali, corroſive ſublimate, alum, &c. From none of thoſe that I have juſt named, can the ſuperſaturated part be ſeparated, either by cryſtallization, ablution with water, or by alcohol; but it can only be done by the aid of ſome other ſubſtance with which it can enter into chemical combination.

Now that, in common kali, the ſuperabundant part underſaturated with carbonic acid is not mechanically, but chemically combined with it, and that conſequently this ſalt has an equal right

to

to be ranked in the fame clafs with the above-mentioned chemically fuperfaturated falts, will be evinced by the following obfervations on its properties.

1. Were the fuperfaturating part of common kali, which moreover is in a very large proportion to the whole merely mechanically combined with this falt, it ought to poffefs a very corrofive tafte, of which, however, nothing can be perceived in its dry ftate.

If to a perfect carbonate of kali we gradually add alkali, by very fmall quantities at a time, the compound does not acquire a cauftic tafte before more of the alkali has been added than what is juft neceffary to its chemical fuperfaturation; and now the falt exifts, as it were, in a twofold ftate of fuperfaturation, namely, both in a chemical and a mechanical one at the fame time: for every falt that is capable of being chemically fuperfaturated is able to combine with only a certain limited quantity of the fuperfaturating fubftance, in order to its fuperfaturation, in the fame manner as it requires alfo a limited quantity in order to its neutralization. Whatever, therefore, is added over and above this determinate proportion remains merely mechanically mixed with it, and may, without diffolving its chemical fuperfaturation, be again feparated from it by the above-mentioned means, in the fame manner as obtains with thofe neutral falts that are infufceptible of chemical fuperfaturation.

2. By means of cryftallization it is altogether impoffible, as I know from repeated experiments, to feparate the fuperabundant portion of the kali from the carbonate, which, however, were it merely in a ftate of mechanical combination,

 ought

ought to be the more eaſily practicable, as kali completely ſaturated with carbonic acid is far leſs ſoluble in water than the cauſtic vegetable alkali.

In order to meet an objection that might be made to me, I muſt take notice, that ſometimes indeed a completely ſaturated carbonate of kali may be ſeparated from common kali by mere cryſtallization; but this can only be done, when the ſuperſaturating part of the ſalt exiſts in too ſmall a proportion to be able to form a true chemically ſuperſaturated kali with the whole of the carbonic acid preſent, as is the caſe in the non-calcined reſiduum from the diſtillation of tartar, and in general in all common kali that has formerly been completely chemically ſaturated, after it has for ſome time been expoſed to the free action of the atmoſpherical air. Such common kali may therefore be juſtly conſidered as a mixture of perfect carbonate of kali and kali imperfectly ſaturated with carbonic acid, both of which ſalts may eaſily be ſeparated from each other by cryſtallization

3. In cryſtallization, the common kali forms cryſtals of a peculiar figure, which differ very widely in their properties from thoſe of the carbonate of kali. The cryſtals of the firſt are much larger than thoſe of the latter; their figure is alſo very different, they contain far more water of cryſtallization, and they are not only much more ſoluble in water, but deliqueſce very ſpeedily upon expoſure to the atmoſphere.

A ſalt, on the contrary, which is inſuſceptible of chemical ſuperſaturation, depoſits itſelf in cryſtals of the form naturally peculiar to it, even though it be mixed with an over-proportion of one

one of its conſtituent parts, in which caſe it ſeparates itſelf from that ſuperſaturating portion, with which it was united in the ſtate of mere mechanical combination.

4. As the cauſtic kali is ſo eaſily, and in ſuch large quantity, ſoluble in alcohol, whilſt the carbonate is altogether inſoluble in this liquid, it would neceſſarily follow, that if their combination were merely mechanical, it muſt be very eaſy to ſeparate them from each other by this means: the contrary, however, is known to be the fact. The common kali attracts, indeed, in conſequence of its deliqueſcent quality, the watery part of the alcohol, without however yielding to it its ſuperabundant portion of kali: and for the ſame reaſon alſo ſalt would not be able to deprive the alcohol of its watery part, unleſs its ſuperſaturating portion were chemically combined with it.

Every other ſalt, on the contrary, which is inſuſceptible of chemical ſuperſaturation, is immediately freed from any ſuperabundant portion of alkali that may be added to it, by means of alcohol, which attracts and diſſolves the ſuperfluous alkali.

5. I have already ſaid, that in chemical ſuperſaturation, as well as in complete neutralization, only a certain definite proportion of the ſaturating or ſuperſaturating ſubſtance becomes combined. I further aſſerted, that whatever is added more than this proportion, combines only mechanically, and may again be ſeparated, either by cryſtallization or by means of alcohol, without affecting the chemical ſuperſaturation that may exiſt in the compound. Now all this is exemplified in the common kali. When this ſalt is expoſed for ſome time to the action of a red heat, a part of its carbonic

bonic acid eſcapes, in conſequence of which it paſſes into the ſtate of mechanical ſuperſaturation, beſides its chemical ſuperſaturation which ſtill exiſts, and thereby becomes very cauſtic, being now a kind of mixture of common, or imperfectly ſaturated, kali, with free cauſtic kali. If in this ſtate we digeſt it with alcohol, the latter acquires an extremely cauſtic taſte, as it holds in ſolution the mechanically ſaturating portion, namely the free cauſtic alkali. If we now repeatedly treat the watery alkaline liquid, which ſeparates itſelf, with freſh alcohol, till no more is diſſolved, we find its ſaline part deprived indeed of its cauſticity, but ſtill in the ſtate of common kali, not of kali completely neutralized with carbonic acid, and that becauſe the alcohol can only act upon the mechanically, not upon the chemically, ſaturating portion.

6. That portion of carbonic acid, by the addition of which the common kali was converted into a ſtate of complete neutralization, is ſo looſely attached to it, that by continued boiling, or even by a ſtill ſmaller degree of heat, conſequently even the humid way, it is expelled and unites with caloric to form carbonic acid gas, and leaving the ſalt in the ſtate of common kali; whilſt, on the contrary, the carbonic acid of this laſt cannot be expelled without a long-continued application of the moſt violent heat of a furnace.

That very looſe combination, which takes place between the neutralizing portion of the carbonic acid and the common alkali, can, in my opinion, only be accounted for by ſuppoſing, that the ſuperſaturating kali, being already chemically combined with the carbonate, can act only with a very ſmall degree of attractive force upon this part

part of the carbonic acid, which therefore, in conſequence of its peculiar affinity with caloric, requires but a ſmall increaſe of temperature to enable it to combine with it, and quit the ſuperſaturating kali.

I find here the moſt perfect analogy with the tartarite of kali *(tartarus tartariſatus)*, in which that portion of kali whereby the tartarous acid is neutralized, is ſo looſely combined, that it may be ſeparated again by means of even the weakeſt vegetable acids, and thus the tartar reſtored to its former ſtate of chemical ſuperſaturation with tartarous acid.

What in this caſe is effected by the weakeſt acids, is in the ſame manner, and for the ſame reaſons, effected upon the perfect carbonate of kali by the caloric, which has ſo ſtrong an affinity with carbonic acid. In both caſes only that portion of the neutralizing ſubſtance is ſeparated with ſuch facility, by which the complete neutralization of the ſalt, formerly chemically ſuperſaturated, had been produced. In either caſe, the ſuperſaturating portion, being already previouſly in a ſtate of chemical combination, can exert only a very ſmall force of attraction upon the neutralizing portion. In tartar, the ſuperſaturating portion is the redundant acid; in the ſalt of which we are here treating, it is the redundant kali.

By what I have advanced in this memoir, it is clearly demonſtrated, that kali is ſuſceptible of two kinds of chemical combination with carbonic acid; the firſt and moſt common, that of chemical ſuperſaturation; the ſecond, that of a very weak perfect neutralization.

Thus it appears, that common kali, like borax, is a ſalt chemically ſuperſaturated with its alkaline baſe.

IX.

IX. *Obſervations on Snow and Rain, their Influence upon Vegetation, and their Combination with Oxygen.* By *Citizen* J. H. Hassenfratz.

FROM THE *JOURNAL POLYTECHNIQUE*.

THE inhabitants of all countries in which ſnow falls upon the earth, agree in conſidering this phenomenon as one of the means employed by nature for increaſing the vigour of plants, and promoting the evolution of their parts. Many are even of opinion, that the winters in which no ſnow falls portend a ſcanty harveſt and a feeble vegetation. They attribute its influence to the ſalts which are ſuppoſed to be contained in this congealed water.

Snow, collected in large quantities, has been melted and evaporated, without any reſiduum remaining; and this experiment has led ſome to conſider the above-mentioned opinion as chimerical, and by carrying their reaſoning too far, even to deny that ſnow exerts any influence whatſoever upon vegetation.

In forming a judgement concerning phenomena of which accounts have been tranſmitted to us through ſeveral ſucceſſive generations, it is neceſſary to diſtinguiſh between the reſults deduced from obſervation, and the explanations that have been attempted to be given of them.

In ſome phenomena, both the whole and all its component parts preſent themſelves to our ſenſes in ſo diſtinct a manner, that no doubt concerning them can remain in the mind of an obſerver who views them with any degree of attention; others again exhibit only ſome fugitive characters, which cannot be diſtinguiſhed except with the aid of proper inſtruments, by a conſecutive ſeries of facts

facts that lead directly to the desired result, or after a number of observations frequently reiterated.

When these characters have been observed by a great number of individuals, and by several generations of mankind, however incorrectly they may have been transmitted down to us, and however obscure the accounts of them may be, the philosopher must be upon his guard against forming too precipitate a decision upon them. The greater the multitude of observers, and the more uniform their sentiments concerning a phenomenon, the greater caution we should employ in investigating it, before we are authorized to contradict a generally received opinion.

The influence of snow upon vegetables is subject to the examination of so large a number of observers, as to render it incredible that so great an uniformity of opinion should prevail concerning it, as actually does, unless its effects were really conformable to what are ascribed to it. I propose, in this memoir, to examine these effects; to attempt an explanation of their cause; and to enquire into the relation that subsists between the explanation that has long since been adopted by agriculturists, and that which results from a more scientific analysis of snow.

That after a very cold and severe winter, vegetation is more rapid and vigorous, in proportion as the plants have been covered by a greater depth of snow, is a matter of fact, confirmed by the experience of all agriculturists.

The cause is simple and natural. All plants are capable of supporting a lesser or greater degree of cold; some perish when exposed to a temperature equal to that of which water congeals, whilst

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upon others the moſt intenſe cold produces no ſort of alteration.

Every plant, therefore, has a certain limited capacity of reſiſting the influence of cold; that is, it cannot be expoſed to a temperature lowered beyond a certain degree, without being frozen, and its vegetable life deſtroyed.

Many plants, when expoſed to a temperature approaching to that which freezes them, are not killed; but in conſequence of the intenſity of the cold, they fall into a diſeaſe of languor, the effects of which they experience during the whole remainder of their exiſtence.

If a ſet of plants that poſſeſs different powers of ſupporting cold be expoſed to the action of a very low degree of temperature, a greater number of theſe plants will die, in proportion as the cold has been more intenſe; but if, by covering them with any ſubſtance, we intercept the cold, and prevent the plants from experiencing a diminution of temperature equal to that which takes place in bodies expoſed to its immediate action, many plants that would otherwiſe have periſhed will be preſerved, and many that would have become diſeaſed will remain healthy and vigorous; and the number of theſe will be greater, in proportion as the ſubſtance with which they were covered has more completely excluded the influence of the cold.

The terreſtrial globe has a quantity of heat accumulated in its internal part, which is very perceptible in ſubterraneous caverns that are deep enough to prevent the cold or heat of the ſurface from penetrating into them. This internal temperature of the earth is about 13° of the mercurial thermometer. Snow is a very imperfect conductor

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tor of heat; it is not easily penetrated by the cold; its temperature at the moment of melting is indicated by the zero of the thermometer.

Snow has therefore the properties of preserving the plants which it covers at a degree of temperature equal to that of melting ice; of defending them against the influence of a more intense degree of cold; of affording them a continual supply of moisture; of saving a great number of them from being destroyed, and a still greater number from becoming diseased; and, consequently, of preserving plants in a state of greater strength and vigour, than they would have retained had they not been covered with snow.

We see, therefore, that a part of the influence exerted upon the vegetable kingdom by the snow may be explained without having recourse to the salts, or the nitre, which it has been supposed to contain, but which experiment and analysis have proved not to exist in it.

The explanation of the influence of the snow, from the constant supply of moisture which plants derive from it, is the result of observations that could not fail to attract the notice of attentive agriculturists of all ages; but the knowledge of its influence arising from its non-conductibility of heat, is founded upon the experiments that have recently been made on the subject of caloric. The ancients had neither a proper series of facts, nor the instruments adapted to this sort of inquiry, but were obliged to make use of such other data, results, experiments, and instruments, as they were then in possession of.

They had observed that metals were rusted by being exposed to the air, in the same manner as when acted upon by acids; they had remarked

that nitre forms spontaneously upon calcareous substances; they therefore concluded that the acid of the air was of a nitrous quality. Nor was this supposition very wide from the truth; since the latest experiments, and those celebrated discoveries that have produced such rapid improvements in physical science, have shewn that the atmospherical air is composed of two elements that enter into the composition of nitric acid, namely, oxygen and azot.

We cannot therefore deny, that our predecessors in natural philosophy have afforded a striking proof of their sagacity and penetration, in discovering long ago, by a combination of indirect phenomena, what analysis has since exhibited to us in the clear light of demonstration.

If snow had only possessed the property of preserving vegetables, and preventing their being destroyed by the intensity of the cold, it is not probable that the ancient natural philosophers would have imagined that it deposited nitrous salts upon the earth, particularly as they might have convinced themselves by a very simple experiment that it contained no saline particles; for they have not attributed the same property to rain water; but having observed that snow corroded leather and other substances immersed in it, in the same manner as is done by acids, and being led to conclude that nitre was contained in the air, it was natural for them to ascribe to this nitre contained in the air the corrosive qualities of the snow, and consequently also its influence upon vegetation.

Having been induced by citizen Guyton to make some experiments, with a view of ascertaining the cause of the difference between the effects

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of rain-water and thoſe of ſnow, upon different ſubſtances, I found it to be occaſioned by the oxygenation of the ſnow, and that theſe effects were to be attributed to a peculiar combination with oxygen that takes place in this congealed water.

I put 1000 grammes of ſnow into one flaſk, and 1000 grammes of diſtilled water into another; into each of theſe flaſks I poured an equal quantity of a ſolution of tincture of tourneſol; and, having placed them in a warm room, I found, after fuſion, that the tincture of tourneſol had acquired a higher degree of redneſs in the ſnow-water, than in the diſtilled water. I repeated this experiment a ſecond time with the ſame reſult.

I afterwards put into the flaſk 1000 grammes of diſtilled water, and into another 1000 grammes of ſnow. Into each of theſe veſſels I put 6,5 grammes of ſulphat of iron, well cleanſed from foreign particles. In the firſt 0,150 grammes of oxid of iron were precipitated, and in the ſecond 0,10 grammes.

As the precipitation of the oxyd of iron is owing to the ſolution of the ſulphat by the oxygen, it follows, that the ſnow contained more oxygen than the diſtilled water; and from the firſt experiment it appears, that it contained a ſufficient quantity of this oxygen to turn the tincture of tourneſol red.

By theſe two experiments it is ſufficiently demonſtrated, that ſnow is oxygenated water, and that it muſt conſequently exert a different influence upon vegetation than ordinary ice.

The experiments of Ingenhouſz upon the germination of ſeeds have ſhewn that the preſence and

and contact of oxygen is absolutely requisite to the evolution of the germen.

The greater part of the plants that are suffered to come to perfect maturity, shed a portion of their seed upon the ground. This seed left to itself, and exposed to the action of the cold, is preserved by the snow which covers it, whilst in the water produced by its melting, it finds a quantity of oxygen, which acts powerfully upon its germinating principle, and determines the seed, that would otherwise have perished, to grow, to unfold itself, and to augment the number of the plants which cover the surface of the earth.

A considerable number of the vegetables appropriated by the art of man to the purpose of nourishment and other uses, are sown in the months of October, November, and even December. Many of these germinate before the action of the cold upon them can affect their vital principle, others are impelled by the snow which covers them, acting by means of its oxygenation upon the germen, to unfold themselves, and to augment the number of useful plants which the husbandman confides to the soil, and thus to increase the produce of his labours.

Here then are three very distinct effects produced by snow upon vegetation: three effects, each of which contributes separately to increase the number of plants that annually spring from the earth, to augment their vigour, and consequently to multiply the produce of our harvests. These effects are: 1. to prevent the plants from being attacked, injured, or destroyed by the action of intense cold; 2. to furnish vegetables with a constant supply of moisture, which contributes to procure them the substances necessary for their nutrition,

nutrition, and to preſerve them in a ſtate of unimpaired vigour and health; 3. to make a far greater number of ſeeds germinate, than would otherwiſe be the caſe, and conſequently to augment the number of plants that grow upon the earth.

Before I conclude this memoir, I ſhall mention ſome experiments which I have made upon rain-water, and which lead to important reſults for the theory of vegetation.

Rain-water does not act upon the tincture of tourneſol and the ſulphat of iron in the ſame manner as ſnow does; whence it ſhould appear as if it did not partake of the property reſulting from its oxygenation. Neverthele ſs, rain-water alſo contains oxygen, but in a ſtate of ſolution, and not of combination as in ſnow; for upon expoſing rain-water to the action of a vacuum, the air extricated has been found to contain a much larger proportion of oxygen than river or ſpring-water, and even than the common air of the atmoſphere.

Atmoſpherical air, expoſed to the action of phoſphorus in the cold, according to the method indicated by Berthollet, diminiſhes by 1,20 of its volume; that is to ſay, the phoſphorus diſengages 20 parts of oxygen from the azot in 100 parts of atmoſpherical air.

The air extricated from the water of the Seine, when tried by the ſame Eudiometer, underwent the ſame diminution.

The air extricated from rain-water, on the contrary, loſt by a ſimilar expoſure to the action of phoſphorus, from 0,32 to 0,40; 0,35 being the average of a great number of experiments. Hence it follows, that the proportion of oxygen, contained in air extricated from rain-water newly fallen,

is greater than that contained in atmospherical air, or in the air disengaged from other water.

Since therefore this difference subsists between rain-water and ordinary water, with respect to the oxygen which they hold in solution, and since oxygen exerts a peculiar influence upon germination, and even upon vegetation, as has been proved by the experiments of Ingenhousz and Senebier, we are authorized to attribute to this cause a part of the peculiar action which rain-water has upon vegetation, different from that produced by the other fluids with which we water them.

X. *List of Patents for Inventions, &c.*

(Continued from Vol. XIII. Page 432.)

Thomas Bowman, of New Bond-street, in the parish of Saint George, Hanover-square, in the county of Middlesex, Peruke-maker; for a new-invented method of making peruques or wigs, with fastenings made of a certain elastic compressed steel spring or springs, and also with other flat springs, or wires, made of steel, for the closer adhesion of the points and wiskers to the head and face. Dated October 21, 1800.

Printed by Nichols and Son, Red-Lion-Passage, Fleet-Street, London.

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XI. *Specification of the Patent granted to Mr.* WILLIAM JOHNSON, *of Widmore, in the Pariſh of Bromley, in the County of Kent, Gentleman; for a Machine, with new Means of obtaining Power in Mechanical Operations of the Nature of a ſelf-moving Power, or perpetual Motion.*

Dated June 10, 1800.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that I the ſaid William Johnſon, in compliance with the ſaid proviſo, do hereby deſcribe the nature of my ſaid invention, and in what manner the ſame is to be performed, and declare that the ſaid machine, with new means of obtaining power in mechanical operations, of the nature of a ſelf-moving power, or perpetual motion, conſiſts in a water-wheel, (placed in the channel of a reſervoir,) having a water-gate on each ſide, the whole conſtructed that they may be raiſed or lowered with the increaſe or decreaſe of the water, together or ſeparate, whenever neceſſary, and being adapted to

render the water, when entering into a basin or reservoir, from the rising of the tides, equally powerful as the falling of the water from such reservoir when the tide has ebbed; and, by means of a surplus power of water, more than immediately necessary for the manufactory, being admitted to act on the water-wheel, a power may be acquired and employed during the turning of the tides, to give the machine perpetual motion and power. Let a water-wheel be constructed and suspended in a movable frame or bearing, placed in the channel of a reservoir, at liberty to be raised or depressed, according to the rise and fall of the tides, having its floats on the plan of the London-Bridge water-works; or as the common under-shot water-wheel, but with shrouding round the wheel on each end of the floats, and closed at the sole; or to be left open at the ends, placing the wheel to pass through a frame or sweep (which rises with it) where the water falls, closely fitted to confine the water, when acting on the floats, from escaping in any direction too soon. The wheel to be placed near the water-gates, according to the stream or fall of water, suspended by its axis, upon the movable frame or bearing, of sufficient length, more than the breadth or height of the wheel, to support the gates whenever necessary.

The water-gates to be formed on the common construction, and placed to move within a frame fitted to prevent waste of water, and conveniently, when necessary to be raised or depressed, when connected to, or separate from, the water-wheel.

The raising and lowering of the water-wheel and gates may be effected by a variety of means; by wheel and pinion, by windlass, or other lever

 powers:

powers: they may almoſt conſtantly be raiſed or lowered by communicating a power from a wheel in the mill, or (being counterpoiſed) from the action of ſmall veſſels reſting on the water under the axis of the water-wheel on its frame. The form of their ſituation, and a mode of raiſing them, will be more clearly explained and underſtood, ſuppoſing a channel for the paſſing of the water, and operation of the water-wheel and gates, be made at the ſide of the mill, over which was a building, having a floor for the operation of the wheel and pinion to raiſe the wheel and gates, and (the floor) ſufficiently raiſed to admit their riſing for any tide expected. Let the water-wheel be ſuſpended, and firmly ſupported, at each end of its axis, upon a movable frame or bearing, each having an upright bar (of proper height) with cogs, which bars are to be kept ſecurely in a proper ſliding place, to be acted upon by the cogged wheels and pinion, reſting above the floor, to raiſe and depreſs the water-wheel. Let it be counterpoiſed by a weight (ſufficient alſo for the water when acting upon it) ſecured to a chain paſſing over a wheel, and fixed to the cogged bars on the frame on which the water-wheel is ſuſpended. The gates to be alſo counterpoiſed, that they may be conveniently raiſed or lowered by lever or by hand; and when raiſed to the height required to give the proper fall of water on the wheel, to have the means, by a chain or bolt, of being attached to the frame, or bearing of the water-wheel, to be raiſed or depreſſed with it, that they (the gates) may be always retained at their proper ſtation, with liberty of being immediately releaſed when it is neceſſary to place either of them entirely up or down. If the cogged

wheel and pinion is adopted to be moved by a perſon employed neareſt the winch to raiſe and lower the water-wheel and gate, (as the tides differ in power and quickneſs of their riſe and fall,) let a gage be placed on the water to direct, by the filling of the baſin or falling of the tide, their proper ſtation; or from the weight of the water-wheel and gate being counterpoiſed, a ſmall veſſel or buoy, under each extremity of the wheel's axis, may be placed, to give and to regulate after it is ſet to work its proper riſe and fall with the tide, without the neceſſity of attendance until the turning of the tides; or, by a properly regulated motion in the mill, a power may be communicated to a wheel, fixed on the winch axis of the wheel and pinion, that would give the proper number of revolutions to raiſe or depreſs the water-wheel and gate to their proper ſtation. Different modes may be adopted in the conſtruction of the gates, and in the form of their being raiſed conveniently or depreſſed to the level of low-water. They may be raiſed and depreſſed in a perpendicular direction within a frame or caſe made to a ſufficient depth in the ground, the frame being made ſufficiently ſpacious to be cleaned or repaired, the bottom of the gate being fitted to the frame ſo as to prevent waſte of water or interruption from ſediment; or let them be made to lay flat at the bottom of the channel at low-water, and upon the riſing of the tide, the gate-end next the wheel being balanced by a weight and unconfined at the other end, (except to ſlide cloſe to the bottom of the channel,) will be eaſily raiſed by preſſing down the weight by hand or lever, and when raiſed to the height intended to be continued, it

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being then attached to the frame of the water-wheel, will riſe with it.

The water wheel and gates being fitted conveniently at any time to be raiſed or depreſſed as may be required, ſuppoſing that the firſt operation of the machine commences at low-water upon the turning of the tide, and that the water has power immediately to enter the baſin, let the gate be now raiſed according to the fall of water intended; ſuppoſe a fall of water is required of about four feet, let the gate be placed five feet above the level of low-water mark, (to check the riſing tide from entering the baſin,) and attached to the water-wheel frame until the tide had attained that height, if the gate is then let down two feet, and again attached to the frame, there will paſs over a large body of water upon the wheel, having a clear fall of four feet, and which fall will regularly continue during the remaining riſe of the tide, in conſequence of the wheel and gate being correctly raiſed by one of the modes before deſcribed; when the tide has nearly or quite attained its height, if the gate is then let entirely down, and the wheel raiſed a little to let the water freely paſs, the baſin in the largeſt works, being of ſmall dimenſions, will be quickly filled by ſo great a ſtream, which may be alſo aſſiſted by having the channel wider than the wheel with a common gate. This being done, the gate of the baſin will now be raiſed to retain the water until the tide has ebbed five feet: this gate being then let down two feet, and attached to the frame of the water-wheel, will give an equal fall of water from the baſin as from the riſing tide, the wheel and gate being retained in their proper ſtation by the ſame mode as when riſing,

riſing, will thus continue the power during the remaining fall of the tide. When the tide has nearly ebbed, the gate will then be quite let down to empty the baſin; and, upon the riſing of the tide, the gate will be placed with the wheel as firſt deſcribed.

Where it is deſirable, as in ſome manufactories where many hands are employed, to give conſtant employment, and it ſhould be required that the machine ſhould have from its own means a perpetual power, let the baſin be made to receive more water than is immediately neceſſary for the manufactory, (part of which to be retained within a ſeparate ſmall baſin for the ſervice of the manufactory at the turning of the flood-tide, and part to cleanſe the main reſervoir) which ſurplus power of water being admitted to act on the water-wheel, let an engine to raiſe water be attached to the end of the wheel-axis which is unemployed, and as the height required to raiſe the water will be but little, a ſufficient body may (moſt conveniently when a powerful ſtream is not neceſſary,) be raiſed into a reſervoir, which during the turning of the ebb-tide, may be employed and conveniently let down by a trough upon the water-wheel, (the water-engine being diſengaged) continuing an equal and perpetual power. The water-wheel in general muſt have on its axis an upright cogged, or face wheel, acting vertically to communicate the power to a trundle, which conveys motion to all the machinery employed; which trundle muſt reſt on the riſing frame that bears up the water-wheel, to riſe and fall with it, and be made of a ſufficient length to paſs up and down, (whilſt acting upon an horizontal-wheel of the mill) for every expected riſe

or

or fall of the water-wheel. For grinding corn, it will be neceſſary to have the mill-ſtones turning always the ſame way; in which caſe, let the axis of the water-wheel be lengthened to admit two vertical cogged-wheels, one on each ſide of the trundle, but placed, that they may act alternately on the ſliding of the main axis. Suppoſing that it requires two inches to diſengage one of them from acting on the trundle, upon the axis being moved two inches, one will be removed, and the other placed to act; in which caſe, upon the turning of the water-wheel either way, the trundle will continue turning always the ſame. The ſliding of the main axis to be effected by a winch turning on a ſcrew; or conveniently, by the motion of a lever, its lower end fitted to receive the leaſt employed end of the water-wheel axis, made to turn within it, the fulcrum of the lever reſting on the bearing or frame of the water-wheel, and its upper end above the floor of the building; from the great power it will give, (the fulcrum being near the axis, or by means of another lever if neceſſary acting upon it) will conveniently ſlide the main axis, and be confined (riſing with it) in any ſtation required.

To deſcribe nearly what ſhould be the dimenſions of the baſin and water-wheel to equal the power required. Suppoſe, to grind and dreſs four hundred buſhels of wheat in twenty-four hours, if the tide is taken at a ſituation to riſe from low-water mark at an average of fifteen feet, and the gates are always placed to give a fall of four feet, having been raiſed up five, and then let down about two feet, (and which would allow nearly one foot for ſlope of current over the gate,) and ſuppoſing it ſhould require ſo much

as twelve thoufand cubic feet of water falling four feet, to grind and drefs one bufhel of wheat, (accounts are publifhed that much lefs is neceffary) it will be found, that from the remaining rife of the tide of ten feet, continuing a pillar of water on the wheel of the height of four feet, and the power of the tides being repeated four times in twenty-four hours, that a bafin one hundred and fixteen yards fquare would be fufficient to give a power to grind and drefs four hundred bufhels of wheat; and as there would be four millions eight hundred and forty-four thoufand cubic feet of water acting with the power of its whole weight falling four feet, this would raife, according to experiments publifhed, nearly four millions of cubic feet of water to the fame height, (the bafin it may be obferved may, in many fituations, at moderate expence with the clay which is removed, be paved with brick, and moft conveniently by this means be kept conftantly clean). The water-wheel to be about ten or eleven feet in length, giving room for increafe of power of ftream, eftimating about four hours for the ten feet of water paffing, and two hours reft at each turn of the tide; the diameter or height to be about eight or nine feet, or any other height preferred, as where the fall of water is conftantly nearly the fame, any diameter moft convenient and leaft expenfive may be adopted; if the wheel is made longer than abovementioned, (and any length neceffary may conveniently be adopted, the axis being fupported at the centre) a greater fall will be obtained. The fall of water mentioned is propofed as appeared convenient, not as a neceffary rule; if the fall is adopted of fix feet, the remaining rife of tide being eight, in place of a fall of

of four with a riſe of ten feet, the advantage would be as forty-eight to forty, giving a power to perform one fifth more work; and by this rule if the tides were taken at a ſituation of eighteen feet average riſe from the low-water mark, a baſin of the ſize here mentioned would be ſufficient in the ſame time to give a power to grind and dreſs ſeven hundred and twenty buſhels of wheat; which, admitting that five tons of water falling four feet, raiſe but four tons to the ſame height, will be found (from eſtimates made by the ſteam engine) equal to the labour of ſeventy-two horſes, or the power of twenty-four horſes working conſtantly.

The eſtimated velocity of the water-wheel to bear no rule with the motion of the underſhot-wheel, the action and effect of the water upon them being ſo different: in the firſt it is confined to act entirely by its weight; on the underſhot-wheel the water is employed to ſuch diſadvantage as to require much greater velocity, generally allowed three times that of the wheel, to act with proper effect; but on the overſhot-wheel, (as they are all conſidered of this deſcription where the water cannot deſcend through a given ſpace unleſs the wheel move with it,) a ſufficient weight of water is only required; its velocity therefore has no rule, and may be greater; the velocity of the deſcent of a body nearly counterpoiſed will be greatly increaſed with little increaſe of weight.

Where it is immaterial which way the water-wheel turns, and if adopted only for raiſing water (as clearing the fen-lands, or ſervice of towns) a crank attached to the water-wheel axis may only be required. The engine barrels for the working of the buckets being made of ſufficient depth

for the raiſing and fall of the water-wheel with the tide; for the first purpoſe in particular, the baſins may generally be formed conveniently for the moſt powerful effect.

A machine (or mill) conſtructed with the moſt perfect form of works deſcribed will be conſidered of the nature of a ſelf-moving perpetual power; that is, of a machine which has the principle of its motion within itſelf; a wheel perpetually revolving from the artful direction (without labour) of the preſſure of the atmoſphere would be of that nature. A mill on the principles deſcribed, without ſeparate reſervoirs, would obtain conſiderable power almoſt immediately upon the riſe or fall of the tides, and may be denominated an improved or perpetual tide-mill. Other forms of a machine on theſe principles, and of water-wheels or gates, may be adopted: the water-wheels of the preſent mills in general would, from being at liberty to be raiſed and depreſſed, give, in many ſituations, additional power, when the ſtreams are overſwelled by floods, or leſſened from drought; or to the preſent mills ſupplied from the tides, whoſe power from the fall of water is continually decreaſing as the reſervoir is emptying.

Various modes may be adopted from which a power may be acquired, by employing the water from the riſing of the tides whilſt paſſing into a reſervoir. Wherever water is admitted upon the riſing of the tides, it may, by the application of a machine upon the principles deſcribed, or by a part of them, be rendered uſeful. In witneſs whereof, &c.

XII.

XII. *Specification of the Patent granted to Mr.* JOHN WHITTON, *of the Town of Kingſton-upon-Hull, and County of the ſame; for a Lead Saccharum, for the Uſe of Calico Printers, and ſeveral other uſeful Purpoſes.*

Dated May 10, 1800.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that in compliance with the ſaid proviſo, I the ſaid John Whitton do hereby declare that my invention of a lead ſaccharum is deſcribed in manner following; that is to ſay: In any quantity of tar-acid, either alone or mixed with any other ſuitable acid or ſubſtance, or compoſition, I diſſolve lead, or white-lead, or red-lead, or litharge of lead, or any other calx of lead, or lead in any other ſtate, or any mixture of them, *ad libitum*, or till the acid menſtruum is fully ſaturated therewith, and will diſſolve no more. Or, I take wood-acid, or any other empyreumatic acid, or any mixture of them, or mixed with any other ſuitable acid or ſubſtance, or compoſition, and I proceed to diſſolve therein lead, or calx of lead, or lead in any other ſtate, or any mixture of them, in the ſame manner as above mentioned. I then filter the ſolution, and leave it awhile at reſt, and then decant and filter it again to ſeparate the impurities. Then I bring it to any deſired degree of greater ſpecific gravity by evaporation; and by evaporation, and timely interceſſions thereof, the ſolution will, at particular periods of the proceſs, form into cryſtals. Thus I make the ſolution;

 and

and by evaporation, or by cryftallization, or by ufing both means, I bring the folution to any required confiftence, ftrength, or fpecific gravity. And this article, in each diftinct ftate, is my lead faccharum, for the ufe of calico printers, which I apply alfo for making white-lead, and yellow-lead, and lead of any other colour for paints, and for feveral other ufeful purpofes. In witnefs whereof, &c.

XIII. *Specification of the Patent granted to* Mr. JAMES SMETHURST, *of the Borough of Southwark, in the County of Surrey, Tin Plate-worker; for his Invention of making a new Lamp and Burner, and of making, moulding, and forming Glafs Lenfes.* Dated October 18, 1791.

WITH A PLATE.

TO all to whom thefe prefents fhall come, &c. NOW KNOW YE, that I the faid James Smethurft, in compliance with the faid provifo, do hereby declare, that my faid invention is defcribed in the plan or drawing hereunto annexed, and particulars thereof hereunder written. In witnefs whereof, &c.

The Particulars of the Invention of JAMES SMETHURST aforefaid, referred to in the above Deed Poll.

The end and defign of this lamp is, to produce a ftrong light, and fo to manage that light, that it

it may be thrown in any required direction; but this is not the only advantage and peculiarity in its construction; for, while this lamp diffuses a strong light to a great distance, it does not create or leave any unpleasant shade or darkness; light is communicated all round from the fore part, the back part, the sides, and the bottom of the lamp. Lamps have been heretofore contrived to give a strong light in particular directions, but in any other, or in most other directions, they have been attended with a disagreeable shade. The end and design of this lamp being thus defined, I shall now particularize the means whereby it may be effected; it consists of a lamp for one, two, three, or four beveled or sloped lenses; the lenses may be plain convex, double convex, concave convex, or of unequal convexities. The bevel to the lenses may be straight, oblique, concave, or convex, in any direction or curve, or of any figure or shape, with many or few angles. One, two, three, or more sides of the lenses, may be beveled, or any portion of its curvation, circumference, and sides. The beveled lenses may be fixed so as to be immovable, or so as to be moved in any required direction; the lamp and lenses are made to hang on the frame, or the frame or lamp, or the part containing the oil and cotton, may be affixed to the lenses; the lamp may be taken out independant of, or with the lenses; the lamp, or part containing the oil and cotton may be made of any shape, form, or pattern; the burners, or piece carrying the cotton or wick, may be also made of any shape or form; it may be fixed or movable, sliding backwards or forwards, or remaining in any given position, to throw or spread the light in any direction or position;

ſition; it may be made to hold either a flat or round, or irregular ſhaped cotton or wick. The burner and lamp may be taken in and out with great eaſe; they may be taken out and lenſes left behind, or they may be taken out together with the lenſes, or uſed without any lenſes at all, if required. The beveled lenſes may be uſed or applied to advantage to lamps for ſtreets, ſquares, houſes, halls, ſtaircaſes, paſſages, lanes, alleys, or for reading, writing, and for all other purpoſes where a ſtrong and diffuſed light is required. Fig. 1, (Plate IV.) repreſents a lamp or burner, with three beveled lenſes *a*, *b*, *c*. The bottom, and two of the ſides, of each of theſe lenſes, are beveled. The lamp *d e*, is of the fountain kind, and is connected by a tube with the part *f g*, which carries the cotton; the burner or tube cannot be ſeen in the drawing, being hid by the lens *b*. *h*, *i*, *k*, is the frame to which the lamp and lenſes are affixed. Fig. 2, repreſents a circular lamp or burner with two beveled lenſes. This drawing ſhews the manner in which the lenſes may be affixed, ſo as to be movable in various directions. *a b c d*, the circular part of the burner or lamp. *e f*, the neck, trough, or receiver, which carries the wick and oil: this is here repreſented as movable in a groove, or may be ſet in different poſitions by the piece *g*. *h i*, is the wire by which the lamp or burner is ſuſpended. Fig. 3, repreſents a rectangular lamp or burner, in other reſpects ſimilar to the former. Fig. 4, repreſents the lamp or burner, with a flat ſliding tube, without the lenſes. Fig. 5, repreſents a beveled lens, having only two ſides beveled. Fig. 6, repreſents an octagon beveled lens, each ſide of the octagon being beveled.

XIV.

Fig. 1.

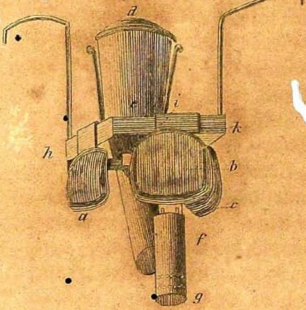


Fig. 2.

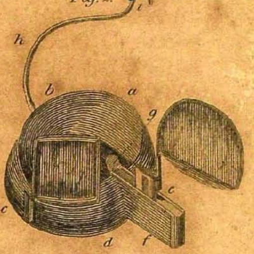


Fig. 3.

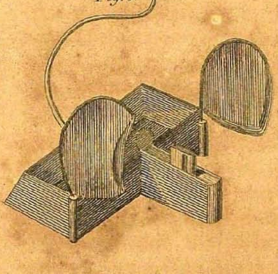


Fig. 4.

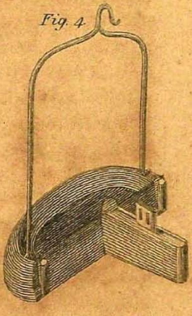


Fig. 6.

Fig. 5.

XIV. *Specification of the Patent granted to* WILLIAM COLLINS, *of Greenwich, in the County of Kent, Esquire; for his Invention of a Preparation or Application of sundry Articles and Materials to be used chiefly for the Preservation of Shipping or Marine Purposes.* Dated April 23, 1800.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said William Collins do hereby declare that the explanation and description of my invention and preparation of sundry articles and materials, or the application thereof, to the preservation of shipping or marine purposes, to be as follows: The principle of one of my inventions or improvements consists in applying mixtures of various metals, and semi-metals, in sheets, plates, or pieces, as a substitute for copper sheets, or any other materials, which have hitherto been applied, to the purpose of preserving ships or vessels, by sheathing or covering their bottoms. I divide my inventions or improvements of this nature into three classes, which, from the appearances the several metallic compounds exhibit, may be called red, yellow, and white sheathing. First, of the red, which consists of copper with a portion of zinc or tin, or other metal or semi-metal, sufficient to render it close, compact, and less liable to corrosion by sea-water, without destroying its ductility, so that the mixture, when cold, may admit of extension by the laminating rollers, or other mechanical means. I have found eight parts of copper to one part of zinc a good composition

tion for the purpofe; but the proportions may be varied to any extent, or tin fubftituted for zinc, provided the ductility, and other properties, of the metal be preferved. Secondly, of the yellow fheathing, which confifts chiefly of zinc and copper, the proportion of zinc being much larger than in the preceding clafs. This additional quantity of zinc produces a confiderable change in ductility. The compound, if expofed, when cold, to the action of the rollers, would be lacerated; and, in order to render it capable of bearing the neceffary mechanical proceffes, it muft be heated, and in that ftate extended and fpread out into a proper form, either by rolling, ftamping, or any other mode of preffure. One hundred parts copper, and eighty of zinc, afford a good compofition; but the proportions may be varied, or other metallic fubftances added, provided the property of bearing the mechanical procefs when heated be not deftroyed. The exact degree of heat is not defined, as it may vary according to the nature of the metallic compound. I have found a low red heat proper for the purpofe of working the above compofition. Thirdly, of the white fheathing, which confifts of tin, lead, zinc, copper, regulus of antimony, or any other metal or femi-metal, capable of being mixed together by heat, and formed, either by cafting or any other mechanical procefs, into plates, or pieces proper to lay upon a fhip's bottom. Sixteen parts tin, fixteen parts zinc, and one part copper, form a good mixture. In the foregoing defcription, I have confidered one example, in each clafs, as neceffary to explain the nature of my invention or improvement. I do not, however, confider any particular com-

pound

pound of metals, or semi-metals, or any mechanical process which may be necessary to give the proper form, as constituting my claim to an exclusive right, (for all these may have been employed before for other purposes); but I declare that my invention and improvement, and the principle thereof, consists in the application of various metallic or semi-metallic compounds, to a purpose to which they have not been before applied, and from which they appear to me, from their superior ability to resist the corrosion of sea-water, preferable to the materials at present in use. I declare another of my inventions or improvements to be, the application of metals, or metallic mixtures, as a substitute for iron in the several parts of the chains and saucers of the chain-pumps, usually called Cole's chain-pump. I have found sixteen parts of copper, to one and a half part of tin, a good mixed metal for this purpose; but copper alone, mechanically hardened, or mixed with a portion of zinc, or a little more or less tin, will answer. I give the above as an example, but by no means confine myself to that mixture. I declare another of my inventions or improvements to be, the application of leather rings, either edgewise or dished, as a substitute for the flat pieces of leather, hitherto applied to the saucers of chain-pumps; by thus diminishing the surface (to which the contraction is always proportioned) the leathers shrink less, and this shrinking has hitherto formed a material defect in chain-pumps, by suffering a large portion of the water to fall back. I also make the working tube, or chamber of metal in lieu of wood and metal: preserving its form, and presenting a smooth and equal surface to the leather

 rings,

rings, enables my pump to work with more effect, and to preserve that effect for a greater length of time. I also use a circular bottom, adapted to the saucers, either of metal, durable wood, lined with metal, or cast-iron, in lieu of the iron roller hitherto employed; by which means my pump draws off the water lower from the ship's well. Another alteration consists in enabling the improved chain-pump to serve the purpose of a small pump, commonly called a hand-pump, by fixing a toothed wheel on the sproket-wheel, or its axis, which being driven by a pinion, of a size proportioned to the power to be applied, may be worked by one, two, or more men, as circumstances may require. The advantages arising from this improvement are, that the space taken up by the hand-pump, as well as the expence of it, will be saved; and any quantity of water, from five hundred weight to three tons *per* minute, delivered by the chain-pump only, without any danger of choaking from the obstructions usually found in a ship's well, to which most hand-pumps are subject. The toothed wheel, by means of a catch, also serves as a pall, to prevent the wheel running back when the men stop working. In the foregoing description of my alterations in the chain-pumps for ships, I consider the machine as improved by Captain Bentinck and William Cole to be well known to all persons interested therein. The want of durability in the iron chain, the irregularity of the wood chamber, the imperfections of the iron roller at bottom, together with the shrinking of the leathers, were defects so great in their pumps as to cause the machine to lose nearly its effect, after being a short time in use; but the excellence

of

of its general principle, for marine purpoſes, induced me to attempt its improvement; and having had proof of the ſuperior excellence and utility of the machine, as altered by me, I claim the benefit which may ariſe from an excluſive right to make and vend ſuch machines, with the alterations or improvements here deſcribed, or any of them. The excluſive right to another improvement, which I claim under the patent, is the application of the ſeveral mixed metals, or ſemi-metals, as formed into plates or pieces, to the covering of houſes and other buildings. In witneſs whereof, &c.

XV. *Hints for managing ſelf-ſown Oats, or Wheat, and ſaving Ploughing and Seed. A Method of converting Wheat grown in a Field to Profit, inſtead of Loſs, by ſowing it immediately.*

By Mr. RICHARD WESTON, *of Leiceſter.*

Communicated by the Author.

CORN of every ſort is, at this time, of ſuch ſerious conſequence, not only to the nation at large, but to each individual, that any hint will I hope meet with candour, as every one is now requeſted to offer any remarks which may conduce to the advantage of the nation.

In walking over ſome lands lately, on which oats grew this ſummer, I found that, from the corn which was ſhed, there now is a very good crop growing. From this obſervation, I have examined ſeveral others, and find them in the

 ſame

ſame ſtate; and in many there are three times the quantity neceſſary, and the plants in general have tillered out ſo much, that, if you choſe, two or three plants might be raiſed from one.

I would therefore ſeriouſly recommend it to thoſe gentlemen and farmers, who happen to have any ſelf-ſown oats now growing, to lay aſide their common prejudices, and carefully examine, and then judge, whether there is not a great probability of their ſtanding for a crop with a very little expence and trouble; as I have known, that in mild winters they have produced a good crop the enſuing harveſt.

On thoſe lands where there is nearly a ſufficient crop, I would propoſe, that the ground ſhould be hoed, and the weeds raked off into the furrows. It would then readily be ſeen where there are any deficiencies, which may eaſily be made good by filling up the vacancies.

If you find ſome lands or accidental places too thick, they may be thinned by hoeing or by harrowing.

On ſome lands turneps have been ſown, and the crop very thin. At ſpring, if the oats ſhould have ſurvived the winter, it perhaps might be more prudent to draw off the turneps inſtead of turning in the ſheep, and then the ground ſhould be harrowed, or, what would be ſtill better, hoed, and the weeds raked off into the furrows.

If any one ſhould have a crop of ſelf-ſown wheat, there cannot be a doubt, but it would be worth while to examine it, and clear the ground of weeds by hoeing; and then at ſpring, if he be not prejudiced againſt the ſyſtem of tranſplanting, there would be an accidental opportunity of putting it into practice, with a crop ready raiſed

raiſed to his hand, without expence, by filling up the vacancies where neceſſary.

If at ſpring any perſon ſhould be inclined to try an experiment of tranſplanting wheat ſelf-ſown, upon other land, the plants may be got up by ploughing the ground, harrowing it and picking out the plants, which would require to have their roots and leaves a little ſhortened, before they are planted.

When the ground is got into a proper ſtate, a furrow three or four inches deep ſhould be made with a plough, and women and children lay the plants in it, at about nine inches diſtance, and the next time the plough will cover them with earth. At firſt, have a rod ten feet long, properly marked at the diſtance you chooſe, which they muſt draw forward each time, but by a little practice they will do without it. This method will be found quicker than planting with a ſetting-ſtick.

You are then to fix at what diſtance you chooſe to plant the next row, it ought not to be leſs than one foot; but fifteen inches would be better, to give room for the roots to extend themſelves, to uſe a hoe to deſtroy the weeds and earth up the plants, or to uſe a horſe-hoe. In this manner proceed till the whole ground is planted, and hoe and earth up the plants during their growth, when you find it neceſſary.

A Method of converting Wheat grown in the Field to Profit, inſtead of Loſs, by ſowing it immediately.

This method has been practiſed by Mr. Doubleday, an ingenious farmer of Coſſington in Leiceſterſhire, with ſucceſs.

Obſerving

Obſerving that his wheat began to grow, particularly on the North ſide of his ſhocks, he was induced to try the experiment of ſowing it immediately.

In the year 1799, it was the middle of September before his wheat was fit to carry. He then ſeparated that which began to grow from the other, and ſowed it.

In November, he ſowed more of the ſame corn, and at the harveſt he found the difference in the crop. By this experiment, he made the *grown wheat* of the ſame value as the other, and gave me lately the account of it himſelf.

XVI. *Experiments and Obſervations on the different Modes of cultivating Wheat. By Mr.* HENRY HARPER, *of Bank-Hall, Kirkdale, Lancaſhire.*

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The Silver Medal was voted to Mr. HARPER, for this Communication.

THE following experiments were executed in a field of eleven ſtatute acres, in my farm, in the month of October, 1795. Twenty yards broad was ſown broad-caſt, and then twenty yards broad in the different modes hereafter explained; ſo that no one mode ſhould have the advantage of the

the other, of having either better land, or in higher condition, and which had all the same dressings, &c. to the time of putting in the seed.

Experiment I. The old mode of broad-cast.

Produce was fourteen threave to the acre, clear of the tithe, and four bushels in the threave. Weight 61½ *lb. per* bushel, neat, which is 7 quarters *per* acre, at 58*s. per* quarter,		£20 6 0
Straw, weight 300*lb. per* threave, at 3*d. per* stone, of 20*lb.* is 3*s.* 9*d. per* threave, and *per* acre,		2 12 6
		£22 18 6
To 105*lb.* of seed, at £5. 2*s.* 8*d. per* quarter *, —	£.1 2 5½	
Sowing by hand, broad-cast, *per* acre,	0 0 6	
		1 2 11½
Amount of corn and straw *per* acre, — — —		£21 15 6½

Experiment II. Cooke's drill.

Produce was 13 threave to the acre, clear of the tithe, and four bushels in the threave. Weight 61½*lb. per* bushel, neat, which is six quarters

* The market price of wheat is taken at the time of sowing, and at the time of reaping, which makes so considerable a difference in the value, *viz.* £2. 18*s.* and £5. 2*s.* 8*d.*

and

and four buſhels *per* acre, and 58*s*. *per* quarter, amounts to — — £18 17 0

Straw, weight 300*lb*. *per* threave, at 3*d*. *per* ſtone, is 3*s*. 9*d*. *per* threave, and *per* acre, — 2 8 9

£21 5 9

	s.	*d.*			
To 87*lb*. of ſeed at £5. 2*s*. 8*d*. *per* quarter, —	18	$7\frac{1}{4}$			
Sowing the ſeed with the drill, *per* acre,	1	6			
Covering the ſeed, after drilling, *per* acre,	1	6			
Twice horſe-hoeing, at 1*s*. 6*d*. *per* acre,	3	0			
			1	4	$7\frac{1}{4}$

Amount of corn and ſtraw, *per* acre, — — — £20 1 $1\frac{3}{4}$

Experiment III. Drills at nine inches, ſown by the hand.

Produce 15 threave to the acre, clear of the tithe, and four buſhels in the threave, weight $61\frac{1}{2}$*lb*. *per* buſhel, neat, which is $7\frac{1}{2}$ quarters *per* acre, and, at 58*s*. *per* quarter, amounts to — — — £21 15 0

Straw, weight 260*lb*. *per* threave, at 3*d*. *per* ſtone of 20*lb*. is 3*s*. 6*d*. *per* threave, and *per* acre, — 2 8 3

£24 3 3

Brought

Brought forward, —				£.24	3	3
To 105*lb.* of seed, at £5. 2*s.* 8*d.* *per* quarter, —	£1	2	5½			
Sowing seed, broadcast, *per* acre,	0	0	6			
Covering seed, *per* acre, —	0	1	6			
Twice horse-hoeing, at 1*s.* 6*d.* *per* acre,	0	3	0			
				1	7	5½
Amount of corn and straw, *per* acre, — — —				£22	15	9½

Experiment IV. Drills made at 12 inches from centre to centre, and three rows dibbled right up the middle of the drill, at three inches from plant to plant, and one grain of corn in a hole.

Produce was 12 threave *per* acre, clear of the tithe, and four bushels and two pecks in the threave, weight 62*lb.* *per* bushel, neat, six quarters, six bushels *per* acre, at 58*s.* *per* quarter, is — —	£19	11	6
Straw, weight 340*lb.* *per* threave, at 3*d.* *per* stone of 20*lb.* is 4*s.* 3*d.* *per* threave, and *per* acre,	2	11	0
	£22	2	6

		s.	*d.*
To 35*lb.* of seed at £5. 2*s.* 8*d.* *per* quarter,		7	3½
Dibbling, *per* acre,		18	0
Covering seed, after dibbling, *per* acre,		1	6
Carried over,	£1	6	9½

Brought forward,	£1 6 9½		
Twice horſe-hoeing, at 1*s.* 6*d.* *per* acre;	0 3 0		
		1 9 9½	
Amount of corn and ſtraw, *per* acre, — —		£20 12 8½	

Experiment V. Dibbled on the land, three rows, at three inches from plant to plant, and one grain of corn put in a hole, and a ſpace left between every third row, for horſe-hoeing.

Produce, eleven threave *per* acre, clear of the tithe, four buſhels two pecks in the threave, weight 62*lb.* *per* buſhel, neat, ſix quarters, one buſhel, and two pecks *per* acre, at 58*s.* *per* quarter, is — —	£17 18 10½
Straw 320*lb.* *per* threave, at 3*d.* *per* ſtone of 20*lb.* is 4*s.* *per* threave, and *per* acre, — —	2 4 0
	£20 2 10½

	s.	*d.*	
To 35*lb.* of ſeed, at £5. 2*s.* 8*d.* *per* quarter, is	7	3½	
Dibbling, *per* acre,	18	0	
Covering ſeed after dibbling, *per* acre,	1	6	
Twice horſe-hoeing, at 1*s.* 6*d.* *per* acre,	3	0	
			1 9 9½
Amount of corn and ſtraw, *per* acre, — — —			£18 13 1

Experiment

Experiment VI. Dibbled on the land, two rows, at three inches from plant to plant, and put one grain of corn in a hole, and a ſpace left between every ſecond row, for horſe-hoeing.

Produce, 11½ threave, *per* acre, clear of the tithe, and had four buſhels and two pecks in the threave, weight 62*lb.* *per* buſhel, neat, ſix quarters, three buſhels, three pecks, *per* acre, at 58*s.* *per* quarter, is — £18 15 2½

Straw, 340*lb.* *per* threave, at 3*d.* *per* ſtone of 20*lb.* is 4*s.* 3*d.* *per* threave, and *per* acre, — 2 8 10½

£21 4 1

	s.	d.	
To 31*lb.* of ſeed, at £5. 2*s.* 8*d.* *per* quarter,	6	7½	
Dibbling, *per* acre,	18	0	
Covering the ſeed, *per* acre, —	1	6	
Twice horſe-hoeing, at 1*s.* 6*d.* *per* acre,	3	0	
			1 9 1½

Amount of corn and ſtraw, *per* acre, — — £19 14 11½

Experiment VII. The land dibbled all over at three inches from plant to plant, and one grain of corn put in a hole.

Produce 10½ threave, *per* acre, clear of the tithe, four buſhels, two pecks, in the threave, weight 61½*lb.* *per* buſhel, neat, and five quarters, ſeven buſhels, one peck, *per* acre, at 58*s.* *per* quarter, is — — £17 2 6¾

Brought forward, —			£.17 2 6¾
Straw, 300*lb. per* threave, at 3*d. per* ſtone of 20*lb.* is 3*s.* 9*d. per* threave and *per* acre, —			1 19 4½
			£19 1 11¼
To 40*lb.* of ſeed, at £5. 2*s.* 8*d. per* quarter, —	£0 8 6½		
Dibbling, *per* acre,	1 1 0		
Covering the ſeed, *per* acre, —	0 1 6		
			1 11 0½
Amount of corn and ſtraw, *per* acre, — —			£17 10 10¾

Experiment VIII. The land dibbled one row, at four inches from plant to plant, and four grains of corn put in every hole, and a ſpace left between every row for horſe-hoeing.

Produce, ten threave *per* acre, clear of the tithe, four buſhels, and two pecks in the threave, weight 60*lb. per* buſhel, neat, is five quarters, five buſhels *per* acre, at 58*s. per* quarter, is		£.16 16 3
Straw, 300*lb. per* threave, at 3*d. per* ſtone of 20*lb.* is 3*s.* 9*d. per* threave, and *per* acre, —		1 17 6
		£18 3 9
	s. d.	
To 45*lb.* of ſeed, at £5. 2*s.* 8*d per* quarter,	9 7½	
Dibbling, *per* acre,	12 0	
Covering ſeed *per* acre,	1 6	
Carried over,	£1 3 1½	

Twice

Brought forward,	£1 3 1½		
Twice horſe-hoeing, at 1*s.* 6*d.* *per* acre,	0 3 0		
		1 6 1½	
Amount of corn and ſtraw, *per* acre, — —		£16 17 7½	

Remarks upon the different Modes of Culture.

Experiment I. I prefer the old mode of broad-caſt upon ſtrong heavy ſoils, ſuch as marl or clayey, or on any land that lies on a cold bottom, becauſe ſuch land requires to be laid round, and in ſmall ridges; in conſequence of which the drill will not work well, and dibbling would not anſwer on ſuch land.

Experiment II. Cooke's drill may anſwer, where the land is flat, even, and dry.

Experiment III. I prefer making the drills at nine inches diſtance, and ſowing the land broad-caſt; but with one-third leſs ſeed than broad-caſt; for though there was more ſtraw in this mode than any other of the experiments, by being ſo thick in the drills, and the ſtraw was lighter, not weighing ſo much to the threave, and the corn appeared not quite ſo well fed, yet, when cleaned, the produce was the ſame weight *per* buſhel, and more in quantity than any other mode. Therefore I prefer this mode to Cooke's drill; for I think it will do with full as little ſeed.

Experiment IV. This mode of dibbling I prefer before any other; for the land was drier, and, in conſequence of the corn being dibbled up the centre

centre of the drill, and by being drier, the plants did not mourn ſo much as the others when the weather was wet.

Experiment V. This mode is not ſo good as two rows together; for, when they came to be hoed, the middle row did not receive ſo much freſh earth as the other two.

Experiment VI. This mode of two rows, I prefer before three; for, when they came to be hoed, they flouriſhed the moſt.

Experiment VII. This mode, of dibbling the land all over, does not do well; for the plants were too thin, and could not be hoed. They did not ſucceed well.

Experiment VIII. This mode ſucceeded the worſt of any; for the ſtems from the plants appeared always more weakly than any of the other modes, although they had rather the advantage of the hoe.

If dibbling be practiſed, it ſhould be on light dry land; but upon any land the expences * of labour will over-balance the ſaving of feed: for the time, and number of hands it takes, prevent

* It has been frequently obſerved, that dibbling may be performed by children, and therefore the expence is light. It is true, that the fingers of young people may be better adapted to handle ſo ſmall a grain as wheat, than the fingers of grown people; yet every one knows the inattention and thoughtleſſneſs of childhood: and becauſe ſuch ſeeds are not ſeparated with eaſe, they will frequently drop, inſtead of one, probably half a dozen into one hole, whilſt the next, through the ſame careleſſneſs attendant upon that age, may omit the next hole; beſides, at this ſeaſon of the year, be the weather ever ſo temperate, the air is ſo cold as to produce a numbneſs in the extremities, to ſuch a degree as to prevent an ability to ſeparate the ſmall grains, the handling of which ſtill increaſes the degree of cold, and conſequently produces greater inactivity.—The ſize even of the leaſt bean renders the practice of dibbling more effectual in that article.

any

any attempts on a large ſcale, at leaſt to do it in proper ſeaſon, and while the land continues in condition; for if it be too wet, it will not dibble at all: and I do not think it will anſwer well on any land; for it is impoſſible to make a hole in the land that you can drop a ſeed into, but it will leave a kind of glaze round the hole, which being ſoon filled with looſe earth, when rain falls, it holds water, and ſtarves the plant. I thought this was the caſe with mine: and if dibbled at the ſame time when the drill or the broad-caſt is ſown, it will be ten days later than either, before it is ripe and ready to cut. However, after it was hoed, the dibbled came on more than the drilled. The firſt hoeing was the laſt week in March; the ſecond, the ſecond week in May. It was properly hoed, not ſcarified, for the earth was laid cloſe up to the plants. The hoeing was performed with a drill of my own conſtruction, which makes five drills at nine inches, five at twelve inches, three at eighteen inches, and three at twenty-four inches. And for hoeing, I have ſhares or ſucks, in the ſhape of a trowel, which I can fix on the points of the drills, and, by drawing it up between the drills, it divides the earth each way up to the plants, nearly equal to hand-hoeing. This drill will either drill or hoe. If the land be not quite even it makes no alteration in the machine, for it depends on the man that holds it, to humour it accordingly as the land lies, which is eaſy to do.

I prefer drilling to broad-caſt, on dry, weak, light, thin ſoil land, for any kind of grain, but more particularly for wheat; for this kind of land is apt to loſe roots the latter end of March and beginning of April, which is the time the firſt

firſt hoeing ſhould take place, and which will prevent that diſeaſe.

The field on which the experiments were made, is a hazel, loamy ſoil, fourteen inches deep; two acres, bottom on a yellow rock; ſeven acres on a marl; and two acres on loamy ſand, about two feet deep, and afterwards marl. This field was marled thirty-three years ago, and has ever ſince been under the plough, nor has reſted more than having a crop of red clover, which was moſtly mown twice in the ſame year, and the ſucceeding year cropped with ſome ſpecies of grain.

In the year 1794 this field had red clover on it, the produce of which was very good. It was mowed twice; and early in the ſpring 1795, I ploughed it up, and ſowed it with vetches, which were cut off for green crop; and as the land was cleared of the crop, it was ploughed thin; and when all the crop was cleared off, it lay about three weeks, and then was ploughed again, but not deeper than the firſt ploughing, upon which it appeared to be quite clean, and in good order. Being rather fearful of its not ſupporting ſuch a crop of wheat as I could wiſh, I made a compoſt, which was part marl and waſte ſoil, to which I put ten ſcore buſhels of lime, eighty tons of night-ſoil, coal-aſhes, ſweepings of ſtreets, &c. and, one week before it was turned over, I trenched into it, a foot deep, three hundred weight of potaſh, pounded fine, and turned it all over together; the lime was in its flowery ſtate: when turned, the field was all regularly ſet over with this compoſt, about twenty tons to the acre, and then ploughed up into butts of three yards broad, then ſown as above deſcribed. — The furrow was about nine inches broad, and four inches and a half deep.

But

But what was the cause of this produce being so much above the general average I cannot ascertain; whether owing to the season, or some unknown quality the potash might add, I cannot say, not having presence of mind to keep a little of the compost clear of the potash. The field has produced good crops of wheat before, and often as much, or more straw, but never so much grain before; nor ever did I hear of so much corn being produced from the same breadth of land. And I should feel some hesitation of laying this account before the public, were not the facts, both as to quality and quantity, confirmed by other testimony than my own, as will appear from the annexed certificates *. The species of wheat is the common yellow wheat, which I got from the South three years ago.

Although the experiments may not claim the premium offered, for a comparative estimate of the broad-cast and drill-husbandry, yet the experiments are of too important a nature to be withheld from the public, and upon too extensive a scale, not to render them of importance. So far as my reading goes, I have never heard of any thing of equal extent and variety. I can venture to affirm, that nothing is asserted herein but the truth, and the results and facts have been carefully ascertained; but the difficulty, the care, the attention, and labour, to keep every part separate, and to weigh each part, is a degree of trouble, of which those who have not experienced such things can have no conception; nor should I have undertaken the task, had I previously

* These certificates are from the Rector of Walton, the Corn Inspector, and other respectable persons, and confirm Mr. Harper's Statements.

known the great care and circumſpection neceſſary to the proper inveſtigation of ſo many circumſtances. Under all theſe embarraſſments I am not diſcouraged, but propoſe to proſecute the ſubject, and endeavour to aſcertain the comparative difference betwixt the drill and broad-caſt huſbandry, having nearly thirty ſtatute acres under that management this ſeaſon, a very ſmall portion of which is dibbled, by way of confirming or confuting the experiments herein mentioned.

The Amount of Produce and Expence attending the Crop of Wheat.

To rent of field,	£.25	0	0	
Taxes, —	2	10	0	
Repairs in gates, fencing, and ditching,	0	7	6	
Three times ploughing, at 7*s.* *per* acre,	11	1	0	
Two qrs. of ſeed, at £5. 2*s.* 8*d.* *per* quarter,	10	5	4	
Once harrowing, at 2*s.* 6*d.* *per* acre,	1	7	6	
Sowing ſeed broad-caſt, at 6*d.* *per* acre	0	5	6	
Weeding, at 6*d.* *per* acre,	0	5	6	
Reaping, at 8*s.* *per* acre,	4	8	0	
Carting home from field, &c. —	4	8	0	
Thraſhing 77 qrs. at 2*s.* 8*d.* *per* qr.	10	5	4	
Carting to market, &c.	5	0	0	
Carting ſtraw to market, at 1*s.* *per* load,	3	17	0	
				£51 3 2

Weighing

Brought forward, —				51	3	2
Weighing ftraw, &c.	0	10	0			
Carting 90 tons of marl, at $1\frac{1}{4}$*d. per* ton,	0	9	4			
Carting 40 tons of foil, at 4*d. per* ton,	0	13	4			
Two hundred bufhels of lime, at 8*d. per* bufhel,	5	16	8			
Carting to the field,	1	4	0			
Eighty tons of night-foil, &c. at 2*s.* 6*d. per* ton,	10	0	0			
Carting to the field, at 4*s. per* $1\frac{1}{2}$ ton,	10	12	0			
Carting out of the ftreets in the night, to a proper place, to be taken away when convenient, at 1*s. per* ton, —	4	0	0			
Three cwt. of potafh, at 50*s. per* cwt.	7	10	0			
Carting ditto to the field	0	1	0			
Trenching potafh into the compoft,	0	2	0			
Turning over the compoft, —	0	6	0			
Carting and fpreading the compoft on the land, 4*d. per* ton,	3	13	4			
				44	17	8
Total expence,				£.123	18	4

By 77 qrs. of wheat (the fuppofed average produce, according to the

 quantity

quantity already dreſſed), at 56*s*. *per* qr.	£.215	12	0			
By 154 threaves of ſtraw, at 3*s*. 6*d*. *per* threave, —	26	19	0			
				242	11	0
Clear profit,				£.118	12	8

This expence of labour is charged as if all the land had been ſown broad-caſt.

N. B. Now the general average which I ſhould have expected from this field, and with which I ſhould have been well ſatisfied, would have been four quarters *per* acre, and then the account would have been as follows:

Forty-four quarters, at 56*s*. *per* qr.	£.123	4	0
The average of the ſtraw expected, would have been one third leſs,	17	19	4
Total amount of produce,	£.141	3	4
Expence, —	£.123	18	4
Clear profit,	£.17	5	0

Although the produce of this amazing crop has not yet been clearly aſcertained, but an average drawn from what has actually been dreſſed, yet a fair account, when the whole is thraſhed, will be carefully taken and preſerved; and, if it be found to vary in a conſiderable quantity, ſhall be faithfully laid before the Society to whom this paper is addreſſed.

XVII.

XVII. *Defcription of an improved Mangle.* *By Mr.* George Jee, *of Rotherham.*

WITH A PLATE.

From the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.

The Silver Medal was voted to Mr. Jee for this Improvement.

THIS mangle is fo conftructed, that the handle is required to be turned one way only; which moves the machine more fteadily, and fafer to the linen, than by varying the turnings of the handle. I have made feveral mangles on this conftruction, at large, which have anfwered the purpofes very well, and given general fatisfaction to all who have feen them at work. It is found, that a woman and a boy are fufficient to work this mangle, and can do as much work (in the fame time) as three or four perfons at any other I have feen.

Description of Plates V and VI.

Plate V. is a perfpective-view of the mangle, when at work; the letters of reference to the feveral parts are the fame as in Plate VI.

A, (Plate VI.) the great wheel, which, in the machine at large, is fifteen inches diameter. B, the

arbor,

arbor, on which the pinion C is fixed. D, the handle of the winch. E, the crank, twenty-one inches long. F, the rod of the crank. G, G, the hollow ſtuds, to lift up the ends of the bed. H, H, the levers. I, I, I, I, the four pullies, fixed on the moveable bed. K, the moveable bed. L, L, the ends of the rollers.

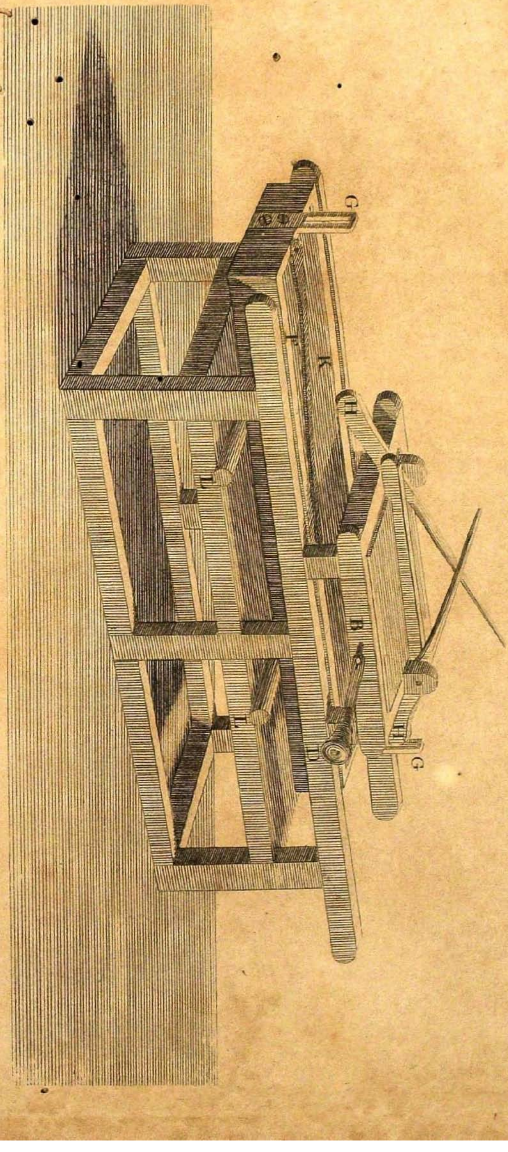
At the bottom of this plate is a front-view of one of the hollow ſtuds G, to ſhew its form, as ſtanding at the end of the bed, and into which the levers alternately enter, when it becomes neceſſary to lift up the bed to put in, or take out, the rollers.

XVIII. *Deſcription of an improved Iriſh Car, as uſed by the late Mr.* Bakewell, *of Diſhley, Leiceſterſhire.*

WITH A PLATE.

From the Communications to the Board of Agriculture.

Plate VII. Fig. 1, repreſents the *improved Iriſh car*, ſo much recommended by Mr. Bakewell, the advantages of which appear to conſiſt in the facility with which it is loaded, (from its lowneſs,) and, when gateways and roads are narrow, much room is gained by having the wheels under the body of the cart: *in ſuch ſituations*, this cart ſeems well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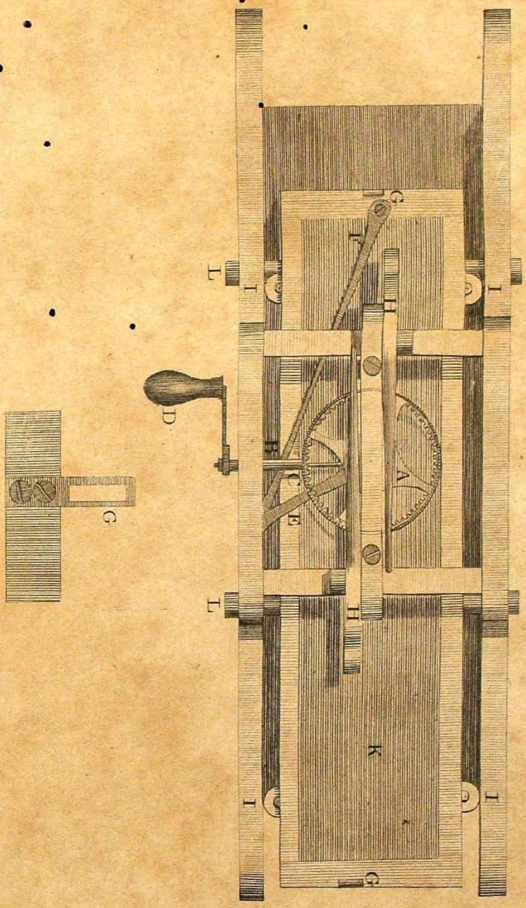
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well calculated for carrying manure, especially on meadow or ploughed land, and for that purpose its wheels ought to have a flat bearing, and to be *at least* six inches in breadth: another advantage of this car is, that, from its construction, the wheels are *necessarily* cylindrical, at least they are necessarily not conical; and the facility of draught arising from this unobserved circumstance, was probably imputed to some other part of the construction; and we see, by experiments *, that (contrary to the general opinion) *the resistance to the cylindrical wheel is not increased, but is diminished by increasing the breadth, and the flat bearing of its rim:* the knowledge of this fact is of very great importance to the farmer, as well as to the waggoner, since by this means he may be enabled in almost all seasons to drive his broad-wheeled carts, &c. on his meadow or ploughed ground, when no narrow wheel can be used; the advantages of which are too well known to be here insisted on: but when the width of gateways, and the breadth of roads will admit of the wheels being placed at the sides of the cart, *without confining the width of its body*, it will probably be more advantageous to have them at the sides, than under the cart.

* See Mr. Cumming's observations on carriage-wheels, &c. vol. XIII. page 326, of this work.

XIX.

XIX. *Account of a Hand-Hoe, invented by Mr.* Mark Ducket, *Junior.*

From the Communications to the Board of Agriculture.

WITH A PLATE.

HAND-HOEING is an operation of ſo much conſequence to drilled crops, and is, in ſome ſituations, ſo expenſive, that Mr. Mark Ducket, jun. invented one for doing more work, and at a leſs expence than the common ones.

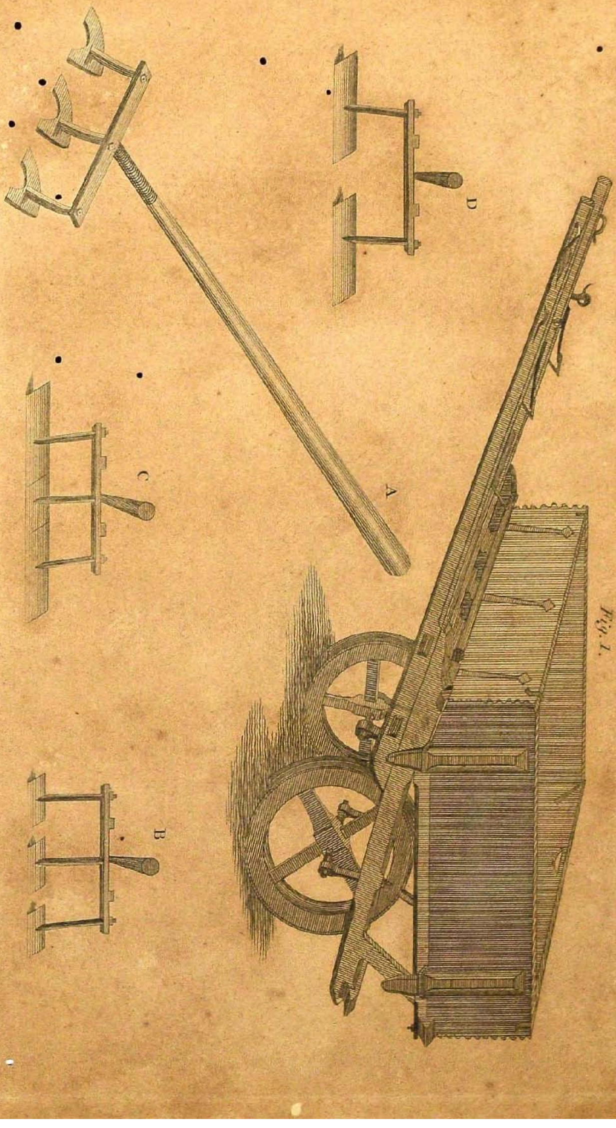
The annexed Plate (VII.) repreſents it in all its variations.

A, is a treble hoe for hoeing three rows at a time; the perſon that holds it *advancing* in the uſual manner. It weighs $7\frac{3}{4}$ pounds *, being heavy enough to give eaſe to its entrance into the earth of light ſoils, and not beyond the power of a woman to uſe that has been accuſtomed to field-work.

With theſe hoes a fine tilth is ſtruck into drills for receiving any ſort of ſeeds, with far more expedition than the common method of ſtriking with the corner of a common hoe, along a pack-thread; for by opening one drill correctly by the

* The weight of Mr. Ducket's hand-hoe, with the three hart-hoes - - - - - 7 lb. 9 oz.
Weight of ditto, with the two 12-inch hoes, is 7 3
Weight of ditto, with the three ſtraight 6-inch hoes - - - 6 11
Weight of the handle without any hoes 4 3
The price of the hand-hoe complete 1*l.* 10*s.*

eye,


A
B
C
D
Fig. 1.

eye, looking at ſtakes ſet up for a mark, all the reſt are made with great truth.

B, is alſo a treble hoe, but the ſhares are ſet for drawing, the perſon holding it going backwards, and in order to give a due preſſure, without fatiguing the wriſt in bearing on it, the inventor has ingeniouſly added the power of a rope, which going round the perſon's body, draws alſo from that ſpot in the handle where the preſſure would be given with the hand.

C, repreſents the hoes as uſed for making trenches in gardens for receiving the manure for planting potatoes; theſe trenches, of any proper breadth and depth, are made very expeditiouſly by ſtriking in a line, drawing up the moulds in a half ridge, and then turning and going back finiſhes the ridge, ſo effective that a woman has, in a very fine tilth, trenched ſhallow for early potatoes an acre in a day.

D, ſhews the two outward hoes, with a ſpace left in the middle to hoe on each ſide a drill of any plant with ſafety and expedition.

Mr. Ducket worked all theſe tools before me *. I alſo wrought with them myſelf; and found them very handy, and ſuch as I conceive can want only to be known in order to be adopted in gardens, nurſeries, and light ſoils.

William Napton, ſervant to Lord Somerville, was at Mr. Ducket's the middle of June, 1799, by his Lordſhip's order, to make himſelf a maſter of Mr. Ducket's newly-invented hand-hoes. He hoed a land of barley containing the 5th part of an acre, drilled at 9 inches, in 36 minutes, but could not work in that proportion; he is clearly

* It does not appear who is the author of this account.

convinced that he could hold it at the rate of two acres a day for any time: used the treble horse-shoe hoes; he found no difficulty in the use of this tool going backwards, but it takes double the time to go forwards which it does to do the work backwatds. He made, in Mr. Ducket's opinion, very good work with it, in barley, oats, and wheat. He also trenched some land up in ridges with the two long and one short hoe fixed, and found the tool so effective and handy for this work, that he thinks he could do twice as much work with it in trenching, as a spade could do in the same time. Likewise he made trenches for potatoe planting, for which purpose, as well as any others in light land, he found it a most handy and useful implement. He tried it upon every sort of soil on Mr. Ducket's farm, and the land he did in 36 minutes was the worst for hoeing he saw on the farm. He found the application of a strap around the waist, to press as above described, to be highly necessary, as it eases the labour very materially.

XX. *Observations and Experiments on Copper.* *By Mr.* Proust.

FROM THE *ANNALES DE CHIMIE.*

IN the distillation of a solution of copper in nitric acid water passes over, and likewise a part of the acid if this was present in any excessive proportion. When the distillation has been carried to a certain point, the nitrate becomes condensed,

densed, forming an incrustation of a green colour and lamellated texture on the sides of the retort. This incrustation cannot be re-dissolved either by agitation or the application of heat; and if the process be continued till the whole is dry, we cannot extract it from the vessel in any other manner than by attempting to separate it with boiling water, or breaking the retort.

This concretion may be lixivated for any length of time with boiling water, being entirely insoluble therein; for the admixture of hepatic water does not indicate the smallest particle of copper in the water of its last lixiviations. This species of nitrate has been treated by Priestley in one of his volumes; but its properties do not appear to me to have been hitherto fully investigated.

Nitrate of Copper at the lowest Degree of Saturation with the Acid.

By this appellation the compound in question ought, I think, to be distinguished, as it uniformly contains a certain determinate proportion of the acid; which, however, is smaller than that which characterises the perfectly saturated nitrate. Ignited charcoal, and sulphuric acid, when applied to this nitrate, immediately disengage the nitric acid from it. Distillation likewise disengages the acid from it, reducing 100 parts to 66½ or 67 of black oxyd. Finally, potash applied to it, with the aid of heat, reduces it to the same quantity of black oxyd, in which the copper is always oxydated in the proportion of 25 *per cent.* But if this nitrate be kept in potash at a low temperature, it changes its colour from green to blue, its quantity is diminished only by sixteen *per cent.*

 and

and it forms a new combination, of which we ſhall ſoon take notice.

This nitrate, therefore, ſtands in the ſame relation to the perfectly ſaturated nitrate of copper, as the Turpeth mineral does to the ſulphate of mercury: and it forms an addition to the claſs of ſalts which combine with their acids according to different degrees of ſaturation; a claſs, for the full diſcovery of which we are indebted to Rouelle.

I ſhall here ſet down the proportions of its component principles.

Black oxyd —	67
Nitric acid —	16
Water — —	17
	100

100 parts of nitrate of copper, at the higheſt point of ſaturation with the acid, and cryſtallized, contain not more than 27 of black oxyd. I have not as yet had leiſure to determine the proportions of its other component parts, and ſhall therefore proceed to conſider the oxydation of copper by the nitric acid.

100 parts of copper, diſſolved and dried in a retort till the oxyd is completely ſeparated, leave an oxyd pretty uniformly 125 grs. in weight, and which is either brown or black, in proportion to the torrefaction or condenſation which it has undergone by the action of the heat. It may be expoſed to a very conſiderable degree of heat without any diminution of its weight, which affords a fixed point for its analyſis far preferable to the precipitation of the copper by the metals, which, of all the means for forming eſtimates, is the moſt

moſt erroneous and fallacious, as we ſhall ſee hereafter.

Of the Carbonate of Copper.

100 lbs. of copper, diſſolved in ſulphuric or nitric acid, and precipitated by the carbonate of potaſh or of ſoda, yield invariably 180 lbs. of green carbonate. If we ſubject them to a gradual diſtillation, they yield 10 lbs. of water, which appear to be no leſs eſſentially requiſite to the colour and compoſition of this carbonate than the acid itſelf; for this water always paſſes over ſucceſſively and conjointly with the acid. Deprived of theſe two principles, the carbonate leaves 125 grains of black oxyd at the bottom of the retort. This oxyd diſſolves in nitric acid, with an extrication of heat, and without decompoſing it. In like manner it is diſſolved by the oxygenated marine acid, in which caſe the oxygene eſcapes in bubbles, the copper not being ſuſceptible of combination with a larger proportion of this principle than that of 25 parts to 100. In every analyſis, therefore, we may take 180 lbs. of carbonate, or 125 lbs. of black oxyd, for the quintal of copper. The native carbonates of copper are likewiſe found oxydated in this proportion.

The following are the component parts of the artificial carbonate:

Copper	—	100
Oxygene	—	25
Carbonic acid	—	45
Water	—	10
		180

The

The colour of this carbonate, which is a bright pea-green, is no leſs uniform than the proportions of its component principles, provided it be not mixed with any hydrate. But in order to obtain this colour in its greateſt perfection, it is neceſſary that we ſhould employ ſome attention in preparing it. As the uniformity of the colour depends alſo upon a certain degree of denſity, we ought to precipitate it with the help of boiling water, or elſe to expoſe the veſſel to the rays of the ſun. By theſe means the particles come into cloſer contact with each other, occupy leſs ſpace, and aſſume the form of a cryſtallized powder, which needs only to be waſhed and dried upon a china plate.

If we wiſh to reduce the carbonate to the ſtate of black oxyd in the humid way, we muſt make it boil for a few moments in cauſtic potaſh, whereby 180 parts of carbonate will be reduced to 125 of the black oxyd.

Of the Native Carbonate of Copper.

When we find that 100 parts of this carbonate, diſſolved in nitric acid, and ſeparated by the alkaline carbonate, yield us 100 parts of artificial carbonate; when we diſcover, that the baſe of both theſe combinations is the black oxyd; we cannot fail to acknowledge that inviſible hand which holds for us the balance in the formation of compounds, and imparts to them all their different properties; and we are compelled to admit, that Nature acts according to the ſame immutable laws, as well in the inmoſt receſſes of the globe, as upon its ſurface, or under the hands of man. Theſe unalterable proportions, theſe permanent proper-

properties, which characteriſe the true compounds both of nature and of art, are as little in the power of the chemiſt, as the law of elective attraction, the prime agent in all chemical combinations. After theſe conſiderations, is it not more than probable that the native carbonate of copper will never differ from that which art forms in imitation of the operations of nature? Do we find any difference between the native carbonate of ſoda and that formed by an artificial proceſs? Certainly not. Why then ſhould there be any between thoſe of copper or other metals, when no cauſe has intervened which could derange the reciprocal tendencies of the agents which form theſe combinations?

Nitric acid deprives the *Malachites* of Aragon of their carbonic acid; and they depoſit one hundredth part of argillaceous ſand. By precipitation we may reproduce 99 parts of artificial carbonate, in which it is ſcarcely poſſible to diſcover a ſingle grain of calcareous carbonate; and if the ſolution be made with the application of heat, no traces of nitrous gas can be perceived, which is a ſufficient proof that copper is inſuſceptible of ſuperoxydation.

100 grains of the ſame ſubſtance, calcined in a crucible by the application of a moderate heat, leave 71 of black oxyd. If we now ſubtract 2 in 100 for foreign earthy particles, we obtain 69 for the quantity of the oxyd contained in the malachite. Now theſe 69 anſwer, within a ſmall fraction, to 99 of artificial carbonate; ſo that there is no difference between theſe two oxyds, and whether formed by nature or by art, the degree of their oxydation is evidently the ſame.

The

The carbonate of copper, which is frequently found mixed with other ores of this metal, is likewise the same substance. Amongst a collection of minerals from Chili, which I have had an opportunity of examining, I have found some which consist of a mixture of the carbonate and the blue sulphuret of copper, so blended with each other, that, without the aid of analysis, it would be impossible to classify them. Dilute sulphuric acid separates from this mineral 58 parts in 100 of native carbonate, which may be reproduced of equal weight by precipitation. We shall see hereafter, that the blue sulphuret, which I separated from this ore, is a compound precisely similar to the artificial blue sulphuret of copper. Copper, like silver, mercury, platina, and some other metals, never admits of the intervention of oxygene in its combination with sulphur; in which circumstance it differs from iron, tin, antimony, &c.

Sulphate of Copper saturated with the acid.

100 parts of this salt lose, in distillation, 36 of water; and the residuum, which is about $\frac{64}{100}$, forms a white powder, which, when mixed with water, occasions an extrication of heat, and reproduces a blue solution. These 64 parts, when calcined in a close crucible, lose the whole of their acid, which does not assume the form of sulphurous acid, as in the calcination of the sulphate of iron. When we heat this last-mentioned substance, it decomposes its acid, at the expence of which its base becomes super-oxygenated, its degree of oxydation being augmented from 28 to 48 *per cent.* In order to learn the nature of the

fumes

fumes which efcape from the calcination of the fulphate of copper, we fhould remove the crucible from the furnace; otherwife the contact of the flame might transform them into fulphurous acid.

The oxyd which remains is black, and poffeffes all the properties belonging to copper oxydated at 25 *per cent.* The component principles of this falt are as follows:

Black oxyd —	32
Sulphuric acid —	33
Water — —	36
	100

Sulphate of Copper with the Minimum of Acid.

In order to procure this fecond fpecies, pour cauftic potafh into a folution of the ordinary fulphate, taking care, however, not to add fo much of the alkali as fhall be fufficient to precipitate the whole of the fulphate. By this method the precipitate fwims in a liquid which ftill contains a quantity of fulphate of copper. Filtrate and wafh the precipitate well. This precipitate we fhall denominate fulphate *with the minimum of acid.* If too large a proportion of potafh have been added, the precipitate, inftead of being green, will be of a blue colour, and poffefs properties widely different, as we fhall fhortly fee. It may, however, be eafily reduced to its firft condition, by plunging it into a folution of blue fulphate. In diftillation it lofes 14 parts of water out of 100. Pure potafh reduces it to 68 of black oxyd. Hence it follows, that in this ful-

 phate,

phate, as in the other combinations of copper hitherto treated of, the metal is uniformly oxydated at 25 *per cent.* The following are its component principles:

Black oxyd	—	68
Water —	—	14
Sulphuric acid	—	18
		100

On the Acetate of Copper.

I have ſhewn, in the ſecond volume of my annals, or rather I have confirmed, what Lavoiſier had already ſuſpected, that there exiſts no real difference between the acet*ous* acid, and that which ſome thought it neceſſary to denominate acet*ic* acid, from a notion that it poſſeſſed a higher degree of oxygenation.

When, by means of the black oxyd, we convert ordinary vinegar into radical, we concentrate it in the proportion of about 58 to 1. It is to this condenſation that we ought, in my opinion, to aſcribe the great ſuperiority of ſtrength obſervable both in the ſmell and taſte of the latter, compared with the former. As to the experiment by which Prieſtley and others ſay they have obtained oxygene gas from the diſtillation of this acid combined with lime, I had not had opportunity for verifying it, neither have I examined the cryſtals, which this vinegar yields upon being evaporated, or re-diſtilled, and which have alſo been noticed, as I think, by Pelletier.

39 parts

39 parts of black oxyd, ſaturated with diſtilled vinegar, generally yield 100 parts of cryſtals of *verdet*; and *vice verſâ*, 100 parts of this ſalt yield 39 of black oxyd, or even 40, if the potaſh gives it a ſlight ſurcharge of foreign earthy particles.

But if the oxyd obtained from the acetate is alſo capable of ſerving as a baſe for the nitrate, ſulphate, &c. without decompoſing any of their acids; there can be no difference between the baſes of theſe ſalts, and the oxyd of the acetate is ſtill at 25 *per cent.* Hence it appears, that a quintal of acetate is compoſed, within a ſmall fraction, of

Black oxyd	—	39
Acetic acid	—	61
		100

If we ſubject 100 parts of verdet to diſtillation, we obtain products which no more correſpond in quantity to the proportions juſt laid down.

Inſtead of 60 or 61 parts of vinegar, we never obtain more than 52 or 53. This loſs depends upon the deſtruction of 9 or 10 parts of the acid, by means of the oxygene of the copper. Hence the new products of carbon mixed with copper, completely reduced in the reſiduum of the diſtillation, the empyreumatic oil, which paſſes off in fumes and contaminates the radical vinegar, and the carbonic and hydro-carbonous gaſes which paſs over together with it.

If we cauſe a current of ſulphurated hydrogene to paſs into a ſolution of acetate, the copper is diſoxygenated, and precipitated in the form of a blue ſulphuret overcharged with ſulphur. If,

 after

after filtrating, we rectify the liquid with a gentle heat, we ſhall find in the retort an acid, not indeed equally ſtrong with that of the diſtilled acetate, but, however, ſufficiently ſo to prove that it contains radical vinegar, in the formation of which it is very evident that the oxygene of the copper has had no ſhare.

Of all the oxyds that of copper is the leaſt capable of decompoſing vinegar, for when united with thoſe of lead, of zinc, &c. no radical vinegar is obtained from it, but carbon, and the gaſſes to which its deſtruction gives riſe.

If we wiſh to obtain the conſtitutive carbon of vinegar pure and in abundance, we only need to diſtil the mercurial acetates. I ſhall examine the nature of theſe when I treat (as I intend ſoon to do) of the different oxydations of mercury.

Of Verdegris.

The proceſs by which copper is converted into verdegris, oxydates it alſo in the ſame degree, as is done by the nitric acid, by combuſtion, &c.

When we ſoak verdegris in water, we find that its maſs conſiſts of an accumulation of ſmall ſhining cryſtals, which in a ſhort time ſeparate from each other and crumble into a green powder. This powder, which is extremly fine, remains for a long time ſuſpended in the water, from which it is very difficult to ſeparate it by lixiviation.

After it has been lixiviated and dried, it is generally found to bear the proportion of 42 or 44 to the former maſs, not reckoning the impurities and ſcales of copper with which it is mixed. This ſuppoſes upwards of $\frac{50}{100}$ of cryſtallizable acetate,

acetate, and that quantity may in fact be obtained by condenſing the lixivium.

This green powder is ſtill a ſalt with a ſmaller proportion of acid. When ſulphuric acid is poured upon it, vapours of radical vinegar are diſengaged. Potaſh deprives it of this acid, and reduces it to a black oxyd, in the proportion of 63 to 100, which in no wiſe differs from thoſe we have already examined.

In diſtillation, it yields water, radical vinegar, and the ſame gaſſes as are obtained by the diſtillation of the acetate. But as this ſalt does not contain ſo large a proportion of the acid, it has no more carbon than is barely ſufficient to reduce the oxyd to the metallic form; nay, even a ſmall quantity more is wanting in order to effect its complete diſoxydation, as ſhall ſhortly appear.

This reſiduum conſiſts of 52 parts of copper mixed with a ſmall quantity of oxyd, which immediately becomes apparent upon adding dilute ſulphuric acid; the liquid acquiring a ſlight blueiſh tinge, and leaving the copper by itſelf. Were it not for the abſence of the carbon, this reſiduum would have been in the proportion of about $50\frac{1}{5}$ parts only, which is the quantity of metal correſponding to 63 of black oxyd.

From what has been ſaid it appears, that the compoſition of copper with the *minimum* of acid is:

Oxyd	—	63
Radical vinegar	—	37
		100

It reſults from all this, that verdegris is a mixture of two acetates, in which ſometimes the one, ſometimes the other, is predominant. I find in my

my notes written ten years ago, that one specimen of verdegris yielded me $\frac{44}{100}$ of green powder.

The boiling of verdegris in water is sufficient to decompose the portion of acetate at the *minimum* which it contains: thus black oxyd is set at liberty and a larger proportion of acetate at the *maximum* is formed, in consequence of the acid of the first being transferred to a part of the black oxyd. When this green powder is kept under water, the heat of the sun is of itself sufficient to reduce it to the state of black oxyd.

It is a mistake to suppose, as some have done, that radical vinegar, as being an acid with an excess of oxygen, is capable of immediately dissolving copper; for, if we keep this metal in a bottle filled with radical vinegar, it tinges it but very slowly; and, in fact, not sooner than ordinary vinegar. And, finally, when we convert copper into verdegris, we constantly oxydate it at 25 *per cent.*

Of the Nature of Copper with the Minimum of Acid, obtained by Precipitation.

If we pour pure potash into a watery solution of nitrate of potash, it forms a precipitate, which at first is blue, but, upon shaking the mixture, soon changes to a green colour, if the liquid contain still a quantity of nitrate that has not been decomposed.

If, on the contrary, we introduce the nitrate into a watery solution of potash, and the latter predominate in the mixture, we obtain a bulky precipitate, of a fine blue colour, but very different in its properties from the former.

The

The firft is a nitrate with the *minimum* of acid, the principal properties of which we have already examined.

The fecond is a peculiar combination of the oxyd and a certain proportion of concrete water, upon which its colour depends. On this account I have denominated it *Hydrate of Copper.*

Examination of the firft Precipitate.

The application of fulphuric acid, or of burning charcoal, immediately difengages from it the nitric acid; and the heat of diftillation, or ebullition with potafh, reduces it to 65 hundredths of black oxyd. In fhort, it differs in no refpect from the nitrate with the *minimum* of acid obtained by diftillation; for, when kept mixed with potafh in the cold, it exhibits the fame habitudes; that is to fay, it lofes only the nitric acid, it acquires a blue colour, and is reduced only to 82 or 83 *per cent.* on account of the water which it retains in the place of the acid.

Examination of the fecond Precipitate, or the Hydrate of Copper.

All the falts of copper, when introduced into cauftic potafh, lofe their acid, and their oxyd is changed into a hydrate. This change takes place with the carbonate, both native and artificial, as well as with the nitrates at the *minimum*, of which we have been treating.

In order to obtain this combination in its greateft purity, it is neceffary that we fhould dilute

lute it with a large quantity of boiling water, and wash and filtrate it well.

When dry, it is not pulverulent, like the carbonates and other precipitates, but has a consistence nearly approaching to that of Prussian blue. If we heat the hydrate, finely pulverized, and spread upon paper, it slowly loses its colour, is deprived of its constituent water, assumes the green colour, and is finally charged into black oxyd. This degree of heat, though it does not burn the paper, is however superior to that of boiling water; for that is not capable of reducing the hydrate to the state of black oxyd.

Whilst it is kept dry, the hydrate of copper is not subject to any alteration; but, when kept under water, it becomes discoloured, is successively decomposed, and at last returns to the state of black oxyd, after undergoing a diminution of its volume. The rays of the sun contribute also to accelerate this decomposition. Undoubtedly, the parts of the oxyd coming to occupy the superior station, in consequence of their mutual attraction, the water is dislodged from them, and separated in proportion as its attraction for the oxyd gradually grows weaker.

One hundred parts of hydrate yield, in distillation, 24 parts of water, 75 of black oxyd, and about one of carbonic acid, a substance which, though foreign to this combination, is found united with it in consequence of causes which shall soon be explained.

If we pour the above-mentioned 24 parts of water upon the oxyd, as taken from the retort, we only obtain a wet powder, not hydrate of copper; for this oxyd is reduced by the heat to a state

ſtate far remote from that degree of tenuity which would be required in order to render it capable of entering into combination with water, and making the latter abandon its caloric.

Without a real combination, ſubordinate to the laws of elective attraction, the oxyd of copper would not, by attracting water, acquire the blue colour; for the blue and green colours by no means belong to this oxyd, as has hitherto been generally believed: they are, on the contrary, a reſult, nay even an infallible indication of its combination with an acid, an alkali, an earth, water, &c.

TO BE CONCLUDED IN OUR NEXT.

XXI. *On the Cauſes of the vinous Fermentation.* *By* B. G. Sage.

FROM THE *JOURNAL DE PHYSIQUE.*

WINE is a product of the decompoſition of ſugar, by means of that motion which ſpontaneouſly ariſes in a ſolution of this ſalt; but this motion, which is termed *fermentation*, cannot take place without the co-operation of an extractive matter, or yeaſt.

The following experiment, which I have ſeveral times repeated with M. de Bullion, proves that this is the fact. Having diſſolved 120 ounces of ſugar in 120 pints of water, into which 24 ounces of pulverized tartar had previouſly

 been

been infused, no fermentation was excited; but it took place as soon as I had introduced into the solution 10 lbs. of chopped vine-leaves.

The wine will therefore be of a more or less generous quality, in proportion to the quantity of sugar contained in the must. This M. de Bullion, at his vineyard, near Linas, gave consistence to his wines, by adding sugar to the must. The superiority of the wine prepared in this manner was very apparent, and the price for which it sold amply indemnified him for the expence of the sugar.

Yeast is the light lees separated from beer that has newly been put into the cask. It is composed of glutinous and extractive matter, with a certain quantity of beer, and forms the most powerful kind of ferment.

If we dissolve sugar in eight parts water, and add $\frac{1}{8}$ yeast, the vinous fermentation is speedily excited. In order to procure the vinous spirit of sugar at a cheap rate, we ought to use molasses, which is nothing else than sugar, mixed with certain foreign particles, the nature of which I have formerly explained.

One hundred pounds of molasses, diluted with 300 lbs. of water, mixed with 12 pounds of yeast, ferment easily, and yield in distillation 25 pints of vinous spirit, of the best quality, and in all respects similar to that obtained from wine.

The end of nature in vegetation is the formation of sugar. This substance gives taste to almost all kinds of fruit, and to the roots of some species of vegetables. It is found essentially combined with the sap of all plants; is purified in their flowers, and collected in their nectaria.

The

The mode in which ſugar is generated, is one of the myſteries of vegetation. This ſalt, the ſweetneſs of which is ſo agreeable to the taſte, is compoſed of 10 parts of a concrete acid, combined with about four parts of an oily matter. It is therefore, to ſpeak chemically, a ſpecies of ſoap; conſequently ſerves to facilitate the ſolution of the eſſential oils.

When perfectly ripe grapes have been dried, they are found to contain cryſtallized ſugar; and it is to this ſalt that the muſt of the grapes owes its taſte.

The unripe grape does not contain ſugar, but tartarous acid, and natural tartar; that is to ſay, an acid oleaginous ſalt with a baſe of fixed alkali.

The tartar which is depoſited from wine, is not a product of fermentation, but a ſubſtance foreign to the wine, and which is ſeparated from it during the progreſs of the vinification. The greateſt part of it is found in the lees of the wine, and the reſt is depoſited on the ſides of the caſk, when the wine has arrived at its greateſt perfection.

The lees of wine ought to be conſidered as the baſe of the different combinations which are formed during the proceſs of vinous fermentation. This lees contains tartar, iron, and a vegeto-animal ſubſtance, which is the principle of the colouring matter.

During vinification, the acid of the ſugar changes its nature, and aſſumes the character of an *acidum pingue*, which we recognize in the two ſpecies of oil which compoſe the ſpirit of wine, and which is alſo a kind of ſoap, formed of more than a ſixteenth part of the concrete acid of ſu-

gar, which incarcerates the odour of the ether and essential oil of the wine, at the same time that it renders them soluble in water. Vinous spirit exists ready formed in wine, where it is inveloped in tartar and an extracto-resinous colouring matter, which, by its decomposition, gives the wine a harsh taste, in which state it is called *absinthiated wine*.

The access of air is necessary to vinous fermentation, which takes place without producing in the fluid any remarkable degree of heat. The motion observed in the fluid is owing to the effervescence occasioned by solution and combination: the elastic fluid which is disengaged, is acid mephitic gas, and ceases to be extricated as soon as the wine is perfectly formed.

During the progress of vinous fermentation, spirit of wine is not disengaged, nor can it be separated from the wine without the application of a heat equal to that of boiling water.

If we leave wine exposed to the air, and collect the exhalations by adapting a capital to the cucurbit, we find that nothing but water has been evaporated. The wine in the mean time turns sour, and at last becomes vapid.

When the acetous fermentation is excited in wine, no inflammable spirit is extricated, although a considerable increase of temperature takes place. It is therefore a mistake, to imagine that the spirituous part of the wine may exhale during the progress of the fermentation by which it is formed, or, when this is completed, by its being exposed to the contact of the air.

When hay or corn has been stacked before it is dry, it undergoes the vinous fermentation, during which a deleterious mephitic vapour is disengaged

engaged from it. I myſelf have known ſeven men to have loſt their lives by ſleeping upon half-dry hay-ſtacks. They do not take fire before the ſap of the vegetables turns ſour in the progreſs of the fermentation.

The art of diſpoſing the farinaceous ſeeds to the vinous fermentation, furniſhes us with the means of forming ſugar. The grain is firſt macerated in water, and, after it has been taken out and ſtrained, it is diſpoſed in layers four inches in thickneſs. It then begins to germinate; the white fibres of the roots unfold themſelves; and when they have increaſed to about two or three inches in length, the grain is dried, in order to be made into wort. This is done by ſteeping the coarſe flour in hot water, and ſtirring it well, till the ſaccharine matter is diſſolved in the liquid, which is then poured off, and condenſed, by evaporation, in boilers, till it has acquired the conſiſtence of a ſyrup. The liquid holds in ſolution a large quantity of ſugar, which is the reſult of the modification which the amylaceous matter has undergone during the progreſs of germination.

One pound of barley flour, which had not germinated, yielded me an ounce of extractive ſaccharine matter; whilſt, from the ſame quantity of barley meal, which had germinated, I obtained more than three ounces of extractive matter, ſimilar to honey in taſte and conſiſtence.

XXII. *On the Pigment called Naples Yellow* (Jaune de Naples), *and the different Methods of preparing it.*

FROM THE *ANNALES DES ARTS ET MANUFACTURES.*

THE yellow pigment, which we uſually term *Naples Yellow*, and the Italians *Giallolino*, is a porous, heavy, and granulated, ſubſtance: it has the appearance of an earth, is very friable, does neither effloreſce nor deliqueſce on being expoſed to the atmoſphere, and its colour is a pale orange-yellow. Reduced to an impalpable powder, it remains for a long time ſuſpended in water, and is at length depoſited in the form of a paſte. When this ſubſtance is boiled in water, the ſolution ſometimes acquires a ſaline taſte. It does not efferveſce with the acids; but it is partly ſoluble in the nitro-muriatic acid. When expoſed to the action of fire, it exhales no ſulphureous vapours; it is difficult of fuſion, and when fuſed it undergoes no perceptible change, except in its colour, which acquires a deeper tinge of red. When fuſed together with inflammable ſubſtances, a regulus is obtained, the appearance of which is ſimilar to that of a mixture of lead of antimony.

This ſubſtance is principally ſent to us from Naples, and moſt commonly in the form of an earthy cruſt, three or four lines in thickneſs. Sometimes it is imported in the form of a coarſe powder.

We are not able to determine at what period this pigment was firſt introduced into commerce. *Pommet* is the firſt writer who mentions the Naples

ples yellow, and he speaks of it as being extremely rare. Kunkel, who has given us a very careful enumeration of the substances proper for colouring glass and potter's wares, does not take notice of it; but if the mere mention of its name be any proof of its antiquity, we may affirm, that it was very well known in Italy towards the close of the sixteenth century. Ferrante Imperato * speaks of two species of *Giallonio*: the one, the product of a calx of lead, is probably the oxyd known in commerce by the name of *Massicot*; and the other is undoubtedly the Naples yellow, though he does not mention the manner in which it was manufactured. In fact, writers seem to have been quite in the dark with respect to the nature of this pigment. Many have supposed it to be a volcanic product of Vesuvius or Ætna †; others have taken it for a species of ochre ‡ formed by nature. *Guettard* looked upon it as a bolar earth §; and Pott, who has approached nearest to the truth, affirmed, that it was a product of art ||.

Fougeroux has at least the merit of having proved the assertion of Pott to be founded in truth, by shewing the possibility of preparing it. According to him, the Naples yellow is made by boiling, for the space of seven or eight hours, at first upon a gentle fire, and afterwards on one

* Ferrante Imperato *Storia Naturale*, Venetia, 1671, fol. 107.

† Among these we may reckon *Pommet*; *two* of the authors of the *Encyclopedie*; *Montamy* (sur la Peinture en émail), the Editor of the *Dictionnaire portalif de Peinture*, &c.

‡ Hill, *History of Fossils*, &c.

§ In his *Mémoire sur les Ocres*, inserted in the Transactions of the *Académie des Sciences*, 1762.

|| Lithogeognosie, tom. II. page 15.

 more

more intenſe, a mixture of twelve parts (by weight) of white lead, one of alum, one of muriate of ammoniac, and three of the white oxyd of antimony with nitre (*antimonium diaphoreticum* *).

Before Fougeroux, who probably had acquired ſome knowledge of this proceſs during his travels in Italy, *Giambattiſta Paſſeri* publiſhed a more accurate one in his intereſting work on the painting of pottery. The ingredients which he mentions are, a pound of antimony, a pound and a half of lead, an ounce of allum, which he calls *allume di feccia*, and the ſame quantity of common ſalt. It is probable that this proceſs was not unknown to Fougeroux, who underſtood Paſſeri's term to ſignify common alum. The celebrated Prof. Leonhardi † has alſo fallen into the ſame error. A variety of circumſtances, and eſpecially the different methods which Paſſeri mentions, of preparing this pigment, give us reaſon to believe, that by the term *allume di feccia*, he meant the tartrite of potaſh (ſalt of tartar); for he frequently uſes the word *feccia* alone, which indiſputably ſignifies *Tartar*.

His proceſſes are as follows:

1, Six pounds of lead, four pounds of antimony, one pound of tartrite of potaſh (*feccia*);

2, Three pounds of lead, four pounds of antimony, one pound of tartrite of potaſh (*feccia*), ſix ounces of common ſalt;

3, Five pounds of lead, four pounds of antimony, ſix ounces of tartrite of potaſh (*feccia*);

* *Mémoires de l' Académie des Sciences*, 1766.

† In his German Tranſlation of Macquer's Chemical Dictionary.

4, Four

4, Four pounds of lead, two pounds of antimony, ſix ounces of tartrite of potaſh *(feccia)*;

5, A pound and a half of lead, a pound of antimony, a pound of tartrite of potaſh *(feccia)*, and a pound of common ſalt;

6, Three pounds and a half of lead, two pounds of antimony, and a pound of tartrite of potaſh *(feccia)*.

The metallic ſubſtances are employed in the ſtate of oxyds; and the reaſon why Paſſeri has given theſe proceſſes with proportions ſo little different from each other, was to obtain various ſhades of the ſame colour, and to exhibit the methods of different maſters, who uſed various proportions in the preparation of the ſame pigment. Since the Memoir of Fougeroux, *Delalande* has deſcribed a proceſs for preparing the Naples yellow, which he received from Prince *San Severo*, and in which only lead and antimony are employed *.

Take lead perfectly oxydated and ſifted; add to it a third of its weight of antimony, prepared in the ſame manner; mix theſe ſubſtances together, and paſs them through a ſilk ſieve. Then take a number of plates of potter's ware, not glazed; cover them with ſheets of white paper, upon which place the powder in layers two inches thick. Place your plates in the upper part of a potter's oven, that they may not be expoſed to too violent a heat; for the reverberation of the flame will be ſufficient to bake the powder. The plates are to be withdrawn from the oven at the

* *Voyage en Italie, par Delalande,* 1786, 9 vol. in 12, page 504.

ſame time with the reſt of its contents, when they will be found covered with a hard maſs of a yellow colour. The fixity of the colour has been attributed by Fougeroux to the antimony and alum; the oxyds of lead not poſſeſſing this quality. However, we ſee no reaſon why the alum ſhould have this influence upon the colour. We well know, that glaſs of antimony is a hyacynth-colour, and that of lead of a yellow. An anonymous artiſt * has given us the following proceſs, which has much ſimilarity with that of citizen Delalande.

Twelve or thirteen ounces of antimony, eight ounces of minium, four ounces of tutty; the whole well pulveriſed, ſifted and mixed together. Place this powder on large plates, as above; bake it in a potter's oven immediately under the vault. After it is baked, take it out; and you will find it hard, gravellated, and of a pretty bright yellow colour, which, when it has been pulveriſed, changes into an orange tinge.

It is a common complaint amongſt artiſts, that they are often deceived in the application of this pigment, on account of the difficulty of procuring it of uniform quality. The difference ariſes, undoubtedly, from the unequal proportions in which the ingredients are mixed, as Paſſeri has already very juſtly obſerved. This inconvenience might eaſily be avoided, if the men employed in preparing this pigment worked according to a regular ſtandard, as in the manufactury of the blue enamels.

It has long been believed, that the art of preparing this pigment was a ſecret in the poſſeſſion

* Traité de la Peinture au paſtel.

of

of only a single family at Naples. Fougeroux speaks of an old man to whom this secret was intrusted, and from whom he could obtain no other information, than that he exposed the metals for the space of twenty-four hours to the heat of a potter's oven.

A precaution with which all artists ought to be acquainted, is to avoid the use of iron in preparing this colour. The contact of this metal gives it a dirty, and sometimes a greenish, tinge. The Naples yellow is chiefly employed in painting with oil-colours, as it affords tints more delicate, brilliant, and rich, than those obtained from ochre, massicot, or orpiment; besides, that they are infinitely more durable. It is particularly used, when the painter wishes to have a yellow resembling that of gold, in which case it is to be prepared with water and gum-arabic, but the most advantageous use to which it can be applied, is in enamel painting on potters ware or porcelain.

Gmelin * has taught us a method of preparing the oxyd of Wolfram, by boiling it in muriatic acid. The result of this process is a beautiful yellow pigment, which may be employed in painting when all the remains of the acid have been washed out of it. This new pigment may serve as a substitute for Naples yellow.

* Gmelin, *Technische Chemie,* page 229.

XXIII. *Conclusion of Mr.* Proust's *Enquiry concerning Tin.*

(From Page 56.)

NITRIC acid attacks this subſtance with an extrication of heat and of nitrous gas.

Marine acid changes it inſtantaneouſly into white muriate: an exceſs of this acid diſſolves it again, forming a colourleſs ſolution.

Sulphuric acid acts upon this oxyd in a peculiar manner. A part of the oxyd, by its tendency to unite with this acid, becomes oxydated to the higheſt point of ſaturation, at the expence of the other part. Thus two new products are formed: the firſt is blue ſulphate, in which the copper is oxydated to 25; and the ſecond conſiſts of a quantity of powder, of a fine red colour, which is nothing elſe than pure copper, and which is no more ſuſceptible of being converted by the muriatic acid into white muriate. When the nitric acid is only at 10 or 15 degrees, it acts upon this oxyd in the ſame manner.

Finally, ammoniac diſſolves this oxyd with eaſe; and this ſolution, which is colourleſs, reproduces, by being expoſed to the contact of the atmoſphere, all thoſe phænomena which have been deſcribed above.

Before I conclude this eſſay, I think it incumbent upon me to confeſs, that though Pelletier has made no mention of this new muriate, I do not doubt that he was well acquainted with it. From his ſilence with regard to the diſoxydation of copper by means of the muriate of tin, I am only authorized

authorized to conclude, that this combination having appeared to him a great novelty, and perhaps at firſt an almoſt inexplicable one, he deferred the examination of it to another opportunity, as is frequently the practice of thoſe who are engaged at the ſame time in a variety of different inquiries. However, though I would by no means pretend to deny, that this indefatigable chemiſt may have been the firſt who has made experiments upon the muriate of tin, I may confidently aſſert, that my diſcoveries relative to this ſubſtance were probably made at the ſame time with his. Having both ſet out from the ſame obſervation, we purſued the ſame track, and the objects which paſſed in review before each of us were ſo much the ſame, that when I read for the firſt time his Memoir inſerted in the *Annales de Chimie*, I could not avoid experiencing a momentary ſenſation of regret: ſo true it is, that, with reſpect to phyſical inveſtigations, no leſs than with reſpect to the gifts of fortune, by attempting to hoard, we run the riſque of loſing what we have already acquired.

I ſhall however add, that Pelletier has gone too far in the concluſions which he draws from the diſoxydation of the molybdic and tungſtic acids, when he aſſerts that they are reduced to the metallic ſtate, when they aſſume the blue colour in the muriate of tin. Theſe acids are reduced to the *minimum* of oxydation, and nothing more; in this ſtate they are ſoluble in water, in the ſame manner as when they have experienced the action of hepatic water. In a word, theſe metallic ſubſtances are in the ſame predicament as copper, iron, and others, the diſoxydation of which is only partial, whilſt, on the other hand, it is complete

plete in the oxyds of mercury, arſenic, &c. I ſhall ſay the ſame of manganeſe, the oxydation of which may in like manner be lowered by the muriate of tin, both in its ſolutions, and in the ſtate of mere oxyd, but never ſufficiently to reduce it to the metallic ſtate. In fact, how ſhould the oxyd, the muriate of tin, in which one part of the tendency to diſoxydation is already ſatiſfied, effect a decompoſition, which tin itſelf is unable to accompliſh?

I have found (as Bergman has alſo done) that tin, in its loweſt degree of oxydation, combines with not more than 30 parts in the hundred; but this oxyd is not free from all combination with muriatic acid; for, upon heating it in a flaſk, I found that it loſt much of its weight, in conſequence of the extrication of fumes of muriate of tin, which were perceptible as well to the ſight as to the ſmell. As to the oxyd at the higheſt point of ſaturation, it may eaſily be reduced by a red heat from 140 to 130; it is then of a blueiſh colour and inſoluble in the acids, which, in my opinion, is to be aſcribed to the torrefaction which it has experienced. From the readineſs with which this laſt parts with its oxygene, I conclude, that we ought not to rely too much upon it in our calculation of tin in the analyſis of bronzes.

XXIV. *Lift of Patents for Inventions, &c.*

(Continued from Page 72.)

WILLIAM PLENTY, of the town of Southampton, Carpenter; for his new-invented pump, and a plough upon an inproved conftruction. Dated October 11, 1800.

THOMAS BINNS, of Great Barlow-ftreet, St. Mary-le-bone, Middlefex, Water-clofet-maker; for his new-invented method of applying heat for the purpofe of melting and manufacturing animal fat, and a variety of other folid fubftances. Dated October 27, 1800.

ISAAC HAWKINS, of Gloffop, Derby; for his new invention applicable to mufical inftruments; the principles of which are alfo defigned to be applied to other machinery.
Dated November 13, 1800.

DAVID MUSHET, of the city of Glafgow, Gentleman; for his new-invented proceffes applicable to metallurgy, or the manufacturing of metal or metals, not only from their metallic ftate or ftates, to the completion of the various articles or utenfils ufually made of fuch metal or metals, but alfo, from the ftate of the ore into their metallic ftate or ftates, in bars, ingots, or otherwife.
Dated November 13, 1800.

JAMES POTTS, of Belford, Northumberland, Clock and Watch maker; for his new-invented artificial

artificial leg and arm, upon a new or improved construction. Dated November 15, 1800.

John Turnbull, junior, of Cordale Printfield, Dumbarton, North Britain, Calico-printer; for his new-invented processes, or improvements of processes, and apparatus applicable to the bleaching or whitening, and to the purifying, washing, and cleansing, of cotton, flax, hemp, silk, and wool; and to the purifying of goods of every description made or manufactured of cotton, flax, hemp, silk, and wool. Dated November 15, 1800.

John White, of the parish of St. Paul Covent Garden, Middlesex, Tin-plate-worker, and James Smethurst, of St. Margaret's-hill, Southwark, Surrey, Tin-plate-worker; for a new-invented lamp and burner.
Dated November 15, 1800.

Thomas Grylls, of Launceston, Cornwall; for his new-invented stop-cock for barrels, and other vessels, which prevents the wasting of liquor. Dated November 15, 1800.

Joseph Sigmond, of Bath, Somerset, Surgeon-dentist; for his new-invented preservative lotion and dentifrice, which he calls the British Imperial Lotion and Dentifrice, for preserving and beautifying the teeth and gums.
Dated November 25, 1800.

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NUMBER LXXXI.

Printed by NICHOLS and SON, Red-Lion-Paſſage, Fleet-Street, London.

XXV. *Specification of the Patent granted to Mr.* SAMUEL WYATT, *of Chelſea College, in the County of Middleſex, Architect; for his Invention of a new Art, or Method of making and conſtructing Bridges, Warehouſes, and other Buildings, without the Uſe of Wood, as a neceſſary conſtituent Part thereof, and with other Advantages and Improvements appertaining thereto.*

Dated June 10, 1800.

WITH A PLATE.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that in compliance with the ſaid proviſo, I the ſaid Samuel Wyatt do hereby deſcribe and aſcertain the nature of my ſaid invention, and the manner in which the ſame is to be performed, as follows; that is to ſay:

Firſt. The principle or nature of my invention, and the manner of performing the ſame, in regard to bridges, conſiſts in uſing or applying pipes, tubes, or other hollow pieces of caſt-iron, in a longitudinal direction, and plates or pieces

 of

of the ſame material, having ſockets on them, to receive the ends or ſhoulders of the ſaid pipes, tubes, or other hollow pieces, placed tranſverſely; and extending from one ſide of the bridge to the other, ſo that when the required number of pipes, tubes, or other hollow pieces of caſt-iron, and of tranſverſe plates, or pieces, are put together, they form the arch, and ſo firmly fix, connect, and unite, all the parts, as not to require the aid of ſcrews, bolts, cramps, or any wrought-iron faſtening whatever; but, for the ſake of giving the joins a more equal bearing, it will be proper to run lead or cement into them.

The manner of covering the ribs, and of fixing the battlements or balluſtrades, as well as the form and deſign of each, may be varied at the diſcretion of the builder; but I prefer the following.

After having fixed the ribs of the arch agreeably to the above principle, and run the arch-joints with lead or cement, as above mentioned, I then fix the plinths on the outſide ribs of the arch, which plinths are afterwards ſecured in their places by the ſtandards of the battlements or balluſtrade. I then cover the ribs with caſt-iron plates, to receive the gravel and pavement, as well as the battlements, balluſtrade, or parapet of the bridge. Theſe plates I make of an arched ſhape, for the ſake of additional ſtrength, and place them ſo that their ſides are ſupported by the ribs of the bridge as abutments. I next fix the ſtandards and the pannels of the balluſtrades or battlements, the ſtandards being made or caſt with grooves on each ſide to receive the ſaid pannels, and a branch or plate at right angles to be ſecured under the foot-pavement; the top of the ſaid

ſaid ſtandards are formed with dove-tailed plugs, to be inſerted in the rail. The whole is then firmly united by the top rail, which is alſo made with a groove in it to receive the top of the pannel of the battlements. It will then be proper to run with lead or cement thoſe parts which require it.

For the greater ſecurity of the ſtandards, I recommend the foot-pavement to be joggled, which will have alſo the effect of keeping it even on the top.

In order to exemplify and illuſtrate the principle of this invention, I annex drawings and deſcriptions of the ſeveral parts which compoſe the bridge, with an elevation, ſection, and plan, of the ſame when put together.

Fig. 1, (Plate VIII.) is a ſide-view of a double tube or hollow piece of caſt-iron, formed at the ends with ſhoulders, to fit the ſockets in the tranſverſe plate or piece; the length, ſtrength, and diameter of which muſt be determined by the ſize of the arch.

a, end-view of Fig. 1.

Fig. 2, front-view of part of a tranſverſe plate, to be caſt exactly alike on both ſides.

b, *b*, *b*, ſockets to receive the ends of Fig. 1.

c, ſection through one of the ſockets on each ſide.

d, *d*, holes left in the tranſverſe plate for the ſake of lightening and ſaving the metal.

The number of ſockets in the tranſverſe plates muſt of courſe always correſpond with the number of ribs of which the arch is propoſed to be made.

Fig. 3, covering-plate, which may be made in any number of lengths to fill the ſpaces between the tranſverſe plates.

 e, ſection

e, section of the same.

Fig. 4, profile of a standard, with a groove to receive the ends of pannels.

f, the branch to lie under the foot-pavement.

g, the plan of the said branch.

Fig. 5, section of the plinth.

Fig. 6, front-view of a pannel.

Fig. 7, a single tube to be applied in the same manner as Fig. 1, where less strength is required, or when the builder prefers the appearance of it to Fig. 1.

Fig. 8, two tubes, to be used in the manner as No. 1, as being more convenient to cast than that figure entire.

Fig. 9, elevation of a bridge, constructed with the double tubes of Fig. 1.

Fig. 10, plan of ditto, shewing the ribs before the covering plates are laid on.

Fig. 11, transverse section of the bridge.

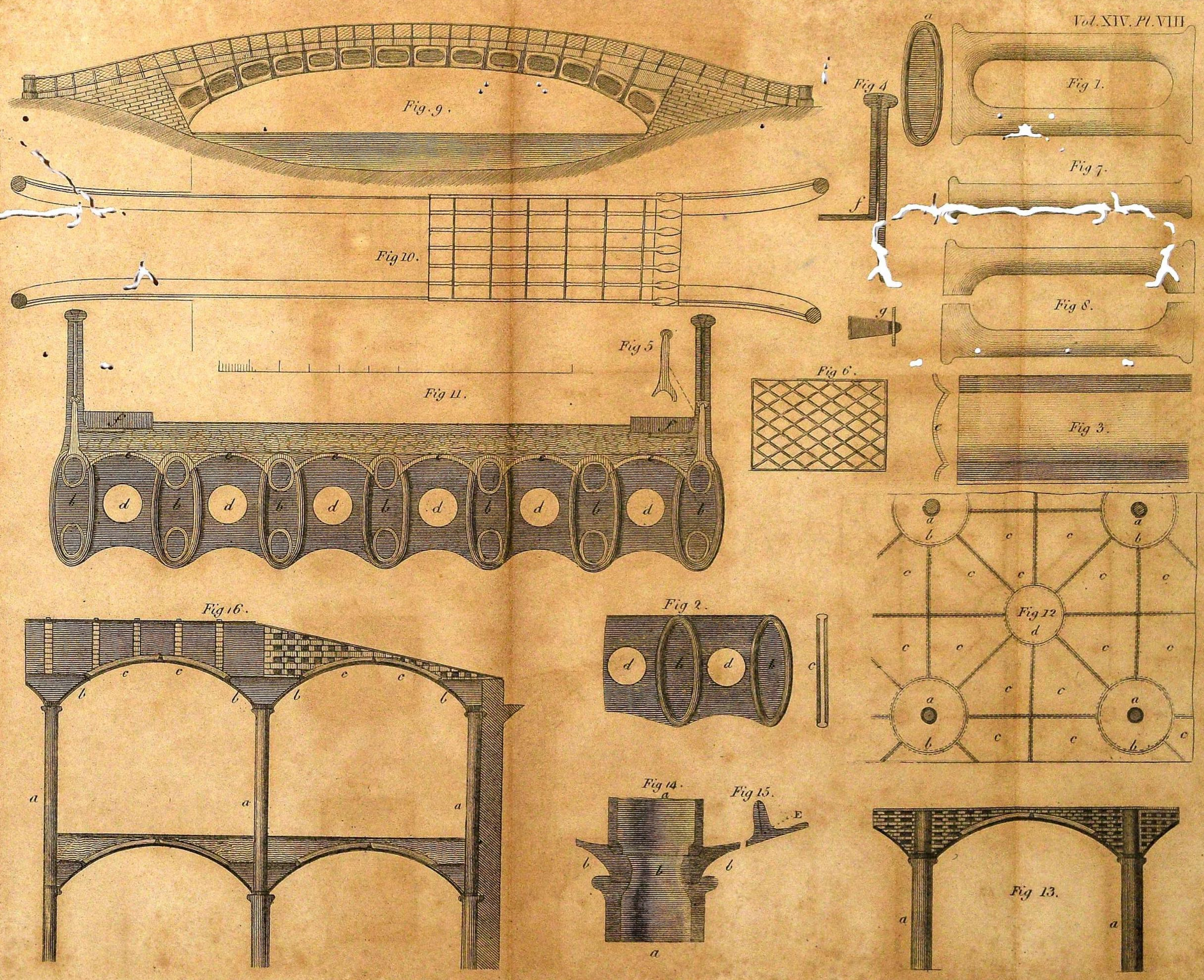
It is perhaps needless to observe, that the number of ribs necessary for any arch, as well as the relative strength of all the parts, must be left to the judgement and discretion of the artist, who directs the building of a bridge upon this principle, as they will vary in almost every instance.

Secondly. The principle or nature of my said invention, in regard to warehouses and other buildings, consists in forming arched cielings of cast-iron, and supporting them and the floors by hollow pillars, cylinders, tubes, or pipes, of the same material. The annexed plan of one compartment of the cieling and section of the same will illustrate the principle, and shew the manner of constructing a building according to it.

Figs. 12 and 13, plan and section of a groin or arched ceiling.

a, a, a, a,

Vol. XIV. Pl. VIII.



a, a, a, a, caſt-iron pillars.

b, b, b, b, circular (or may be made octangular) plates or pieces of caſt-iron, forming part of the arched cieling, reſting on the tops of the pillars of the lower ſtory, and receiving, when more than one ſtory is required, the bottom of the pillars above them.

c, caſt-iron plates, forming part of a regular arch or groin between the pillars.

d, a circular (or may be octangular) plate of caſt-iron, forming the centre of the groin.

The whole of theſe plates, for the ſake of faſtening and ſupporting them by each other, are made with flanches, grooved and tongued, as ſhewn at E, Fig. 15, (which is a ſection of the joint, upon a large ſcale,) and ſhould be run with lead or cement when put together; but any other mode of faſtening and ſupporting them may be adopted that the builder prefers.

Fig. 14, ſection of the top of a lower pillar, and the bottom of an upper one, with one of the plates *b.*

Fig. 15, ſection of the joints by which the plates are connected.

Fig. 16, ſection of part of a roof formed upon a caſt-iron vaulted cieling, upon which is built half-brick walls, to carry ſlate or other covering.

N. B. The ſame letters refer to the ſame parts as in Figs. 13, 14, and 15. The ſpandrels of the arches of the cielings may be filled and raiſed to a level with the crown of the arches by brick-work, chalk, or any ſolid matter, upon which may be laid either ſtone or brick pavement, or boards, if required, for the floors.

In witneſs whereof, &c.

XXVI. *Specification of the Patent granted to* RICHARD SHANNON, *of Charlotte-ſtreet, in the Pariſh of Saint Pancras, in the County of Middleſex, Doctor of Phyſic, and* ROBERT BURNETT, *of Vauxhall, in the County of Surrey, Vinegar-maker; for the Diſcovery of a Principle and Invention of a Method of improving the Proceſs of Fermentation, by which Porter, Beer, Ale, Malt, and Molaſſes Waſh, Wine, Cyder, and all other ſaccharine and fermentable Fluids, may be conducted with Certainty through the vinous Proceſs of Fermentation in mild, warm, hot, and cold Weather, without being materially injured, as heretofore, by the different Changes of the Atmoſphere; and ſubſequently through the acetous Proceſs of Fermentation, when any of them are intended for Vinegar, with natural or artificial Heat, jointly or ſeparately; improving the Flavour, Strength, and Quality in both; and attended with great Diſpatch in the acetous Proceſs of Fermentation, both in the Field and in the Stove-Chamber; with a new Improvement in the Brewing Utenſils, and a ſuitable pneumatic Apparatus, which facilitates the Proceſs in each Kind of Fermentation.*

Dated June 19, 1798.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that in compliance with the ſaid proviſo, I the ſaid Richard Shannon do hereby declare, that my ſaid diſcovery, and application of a new principle and invention of a method

method of improving the procefs of fermentation, by which porter, beer, ale, malt, and molaffes wafh, wine, cyder, and all other faccharine and fermentable fluids, may be conducted, with certainty, though the vinous procefs of fermentation, in mild, warm, hot, and cold weather, without being materially injured, as heretofore, by the different changes of the atmofphere; and confequently through the acetous procefs of fermentation, when any of them are intended for vinegar, with natural or artificial heat, jointly or feparately; improving the flavour, quality, and ftrength, in both; and attended with great difpatch in the acetous procefs of fermentation both in the field, and in the ftove chamber; with a new improvement in the brewing utenfils, and a fuitable pneumatic apparatus that facilitates the procefs in each kind of fermentation: correfpondent to thefe intentions, are faithfully defcribed, by me, the faid Richard Shannon; as follows. The worts, extracted from the grift of a proper length, with liquors (or water,) turned over at a fuitable heat, the ftanding of the taps, after each mafhing, is to be regulated by the nature and compofition of the grift: the whole of the worts, extracted and cooled, in the ufual manner, or by the means, by me propofed, to the temperature of the atmofphere, or to any temperature required, by means of my apparatus, and committed to fermentation, with a due proportion of good found yeaft, or any other convenient fubftitute for yeaft, in a gyle tun, fermenting back, working tun, fquare, &c. fufficiently capacious, and of the following defcription: *In the brewery*; when the worts extracted are intended

tended for the brewing beer, ale, porter, &c. a close gyle tun, &c. is indispensibly necessary for confining and compressing the gas, extricated from the fermenting fluid and for the saving and applying it, as hereafter described: gyle tuns, &c. intended to embrace the whole of the advantages, derivable from these improvements, in addition to being close and air tight, should be fitted up with an attemperator, to regulate the necessary degree of heat wanted, to uniformly preserve the temperature of the fermenting fluid, at any required standard, instead of being subject to the influence of every change of the atmosphere, which it has hitherto been, to the great injury of fermentation, and sometimes to the partial or total loss of whole gyles. This can only be remedied, by the application of a suitable attemperator, introduced into the gyle tun, fermenting back, &c. when the barometer, thermometer, electrometer, &c. informs us of the present state, or gives notice of any approaching change of the atmosphere: if from cold, to mild or warm weather, cold air is to be passed; when the change is from mild or warm, to sudden and extreme frost, so as to nip or suspend beginning fermentation, warm air or steam is to be passed. It not unfrequently happens, from the hurry of business, the changes of weather and other concurring causes, that the worts in the coolers must be let down into the tun, before cooled to the temperature of the atmosphere, to make room for others, turned out of the copper, or to be raised from the under back; or even when cooled to the temperature of the atmosphere or external air, yet are not at some seasons sufficiently cool to advantageously bring together

gether and ferment with ſafety to the gyle, or the future beer, ale, waſh, &c. hence cold air muſt be paſſed, or the ſpiral pump and cooling attemperator uſed, to paſs the worts through and cool them in their way from the copper or under back, to the gyle tun or fermenting back; advantages too obvious to the brewer, diſtiller, &c. to need any farther illuſtration; to whom it muſt be equally obvious, that the application of the attemperator, fixed or moving, in regulating the temperature of the fermenting fluid, both in the gyle tun and in the cleanſing vat, is accompanied with great and important advantages. *Cleanſing vat.* the temporary expedient of the porter-brewer, &c. for breaking the force of the fermentation in the gyle tun, and ſubſequently cleanſing of the beer, has uſually been to draw it off into barrels, placed upon ſtillion troughs to receive the dregs, (ſeparated by the conſequent cooling and condenſation of the fermenting fluid,) thrown up to the ſurface, and diſcharged at the bung hole of each barrel, to ſupply the waſte of which they are occaſionally filled up with ſome of the ſame gyle of beer. The obvious motive for dividing, and thereby cooling the fermenting fluid, is the impracticability of bringing about a ſeparation of its parts, and conſequent decompoſition of its feculencies, with the ſame degree of heat generated by fermentation; which, if kept up, would not only prevent, but at the ſame time induce the acetous fermentation, excited by the heat and turgency of the fermenting fluid. Cleanſing in quantity not only preſerves the ſtrength and ſpirituoſity of the beer, produced in the tun, but alſo increaſes it; which cleanſing in barrels partly loſes by too ſudden a cooling

and ſeparation of its parts; the beer produced is conſequently weaker and thinner, and makes more grounds and leſs beer. Cleanſing in quantity can be moſt advantageouſly regulated to any temperature, and at any ſeaſon of the year, a circumſtance highly beneficial to ſtarting; when different gyles are ſtarted into the ſame ſtore vat, to prevent fretting and ſubſequent ſowering, they ſhould be brought together at nearly one temperature. This can only be done, by means of a fixed or moving attemperator. Fretting ariſing from change of temperature in ſtore vats, can be immediately extinguiſhed by the ſame means. The attemperator may be of any figure, and made to take that form moſt commodious, and beſt ſuited to the uſe it is adapted; or its ſhape may or may not aſſume that of the veſſel it is applied to, or it may be made to move and tranſfer its uſe with itſelf from veſſel to veſſel, or become a fixture to any one. Here follows a deſcription of its principle and application, which acts ſo general and important a part in condenſing, cooling, heating, and adjuſting the temperature of worts, waſh, and other fermenting fluids, as thoſe prepared or preparing for beer, ale, wine, cyder, vinegar, ſpirits, &c. It may be made of metal, ſtone, earthenware, wood, &c. but metals from their known conducting power are the moſt fit to take up heat, and tranſmit it to the air or other cooling medium, and conſequently of procuring and preſerving an equal temperature in the manner propoſed, and of courſe equally fit to communicate heat, and of bringing any cold fluid to a required temperature, by means of a heating medium, and of raiſing and lowering the temperature to any degree between the freezing and boiling

boiling points. The air of the atmosphere, which is the cooling medium employed, being itself subject to all the changes of temperature impressed on it by the diurnal visitation of the sun and its nocturnal absence, alternately heating and cooling it; the influence of which may be here effectually obviated, by passing the air of the atmosphere through water, or any artificial mixtures capable of producing heat or cold by condensation on, and evaporation from off the surface of the attemperator, as occasionally wanted. Condensation and evaporation being the secondary causes of heat and cold, the presence or absence of the sun being the first, the change of the temperature produced by this great first cause occasions the vicissitudes of winds, and they both together form the shape of our atmosphere, the medium by which nature performs all her operations; the receptacle and solvent of all bodies; the grand chaos, into which all matter returns, and from whence all matter is drawn; the prolific circle of nature, that decomposes all bodies and resolves them into air, of which our atmosphere is composed, and from that atmosphere recomposes all those bodies again with which we are at present acquainted. In the formation of the attemperator, the figure must always be subservient to the end proposed; the ruling maxim of its structure should be, to give its plicatures the greatest possible breadth and length, with the least possible depth, in order to produce the greatest possible condensing surface, with the least possible receptive capacity; by which means the heating and cooling mediums are brought to the nearest possible contact, a principle as easy to be understood as Columbus's

egg, when once made known. As it muſt from this plain definition be obvious to every one, that ſo near and extended a contact of mediums of different temperatures, muſt almoſt inſtantaneouſly aſſimilate them to one temperature compounded of them both, a quick repetition of either muſt bring the other over to its ſtandard heat or cold almoſt immediately. Hence their infinite uſe in attemperating, condenſing, rarification, heating, cooling, &c. Fully as demonſtrative, and equally ſimple and effective, is my mode of applying the air of the atmoſphere to thoſe important and deſirable purpoſes, in quantities adequate to the end propoſed, with ſcarcely any trouble, and with little comparative expence. The combuſtion of the fuel employed under the copper, ſtill, ſteam-engine, &c. is more than ſufficient for every purpoſe of the attemperator, and ſome others to be preſently enumerated. A chaldron of good pit-coal weighs about three thouſand ſuttle pounds, which conſumes in burning full one hundred and twenty thouſand pounds of atmoſpheric air, every pound of which, and many more, neceſſarily paſs through the fire-place, in which it is burnt. This air admitted by a door, window, or other ſuitable aperture, and conducted by a pipe, trunk, or canal, to one, two, or more folds of the attemperator, and laid on in any quantity, proportioned to the intended effect, by a ſliding cock, proportionably large, while the fluid to be cooled paſſes either between two folds of the paſſing air, or the paſſing air through two folds of the attemperator, containing the fluid to be attemperated, that is, the air for the ſupport of the combuſtion of the fuel either paſſes between one or two folds of the attemperator,

tor, containing the fluid to be attemperated, according as it is to be cooled, quicker or ſlower, and the indraft of the air regulated in proportion. When the fire requires a leſs portion of air than may be wanting for cooling or attemperating any fluid, as worts, waſh, beer, diſtilling fluids, &c. the redundance may be let off to waſte, or tranſferred alternately from copper or ſtill to ſteam-engine, as wanted, or as one or other of them is cooled, damped, or ſlackened. In regard to the air completely filling up the interſtices between the folds of the attemperator through which it paſſes, there can be no doubt of that, when we come to conſider, that the bulk occupied by each pound of atmoſpheric air is ſixteen cubick feet, fifteen or twenty pounds of which is a *content* equal to the receptive capacity of moſt attemperators that may be applied, when made on the principle already propoſed, and allowing for the expanſive ſpring of atmoſpheric air, one million nine hundred and twenty thouſand cubic feet of which is the produce of one chaldron of coals, which is more than equal to cooling or condenſing any quantity of water or other fluid which that quantity of fuel can heat, or convert to vapour or ſteam, although air is eight hundred and fifty times lighter than water. We have ſeen that air may be cooled; it may alſo be heated, or ſteam may be employed as the heating medium, and applied in ſimilar manner. Spiral pumps, and ſpiral ſhoots, may be truly called a ſpecies of attemperators; they conſiſt of a flatted tube of any number of inches broad, proportioned to the pump or ſhoot they are to circuminvolve, and need not be more than an inch or an inch and half deep, and of length proportioned to the magnitude

nitude of the pump or ſhoot, and the number of convolutions it is to make round either of them. This pump may be made to act in a horizontal as well as a perpendicular poſition; when horizontal it acts as a ſhoot, or a covered ſpout, or trunk, and may be uſed to convey fluids in any direction, and cooled in a ſimilar manner by a flatted ſpiral tube. The worts from the underback in their aſcent through this pump are cooled by the denſe air of the atmoſphere, compreſſed through the ſpiral tube circuminvolving it, in its paſſage to ſupport the combuſtion of the fuel under the copper, ſtill, or engine, with a velocity proportioned to the quantity of fuel impacted and ignited together, and may advantageouſly be applied, as a mill power, for grinding, raiſing of fluids, &c. as well as to all the purpoſes in which the attemperator is uſed either alone or in conjunction with it, and with ſimilar effect. Theſe pumps and ſhoots, although called ſpiral, are not confined to any form or figure, the principle on which they are founded, as in the attemperator, admits of any form or figure that may be found neceſſary. By this mode of work the worts cannot be oxygenated, as they now are, by imbibing from the air a tendency to acidity by having the whole ſubſtance of the fluid expoſed to the influence of the atmoſphere at no greater depth than from one to two or three inches deep on the extended ſurface of the broad coolers now in uſe, by which they are oxygenated or acidified in the cooling; to the advantage of avoiding which, they will be found to owe much of their future preſervation or keeping quality with reſpect to the brewer, and totally obviate their preſent tendency to acidity in the diſtillers fermenting-

back,

back, to which their long-protracted fermentation very much expoſes them after ſuch atmoſpheric expoſure in the coolers, and by which injury they incur a proportionate decreaſe of ſpirit: a barm ſafe may be very beneficially applied over or on one ſide of the gyle-tun or cleanſing-vat to receive the yeaſt and ſeparate the beer from it, as ſtillion-troughs were formerly uſed to do; but when a barm ſafe is employed the gas *can*, alſo *may*, be ſaved and applied to the uſes intended, it being alſo an air-tight veſſel, its figure is not of much importance. Impregnators are air-tight veſſels, or iron bound vats of ſimilar ſhape to brewers ſtore-vats or diſtillers fermenting-backs; they are to be fitted up with exhauſting and injecting cocks, valves and tubes, to promote and keep up a circulation during the impregnation; impregnation is for increaſing the ſtrength, ſpirituoſity, and quality, of the fluid impregnated; which may be done by impregnating fermenting-fluids with their own or other gaſes, or bringing fluids already fermented, as beer, wine, &c. forward, giving them pungency when flat, recovering them when ſour, and giving brightneſs and tranſparency to gray or other foul malt liquor, wine, &c. It muſt be evident to every one that gyle-tuns, cleanſing-vats, ſtore-vats, &c. when uſed for the ſame purpoſes, muſt be fitted up in the ſame manner

Diſtilling. Diſtillers call their gyle-tuns fermenting-backs, of which they employ from *twelve* to twenty or more, and as they protract their fermentation from ten to twelve days and often to a greater number, they have much more opportunity of advantageouſly employing theſe improvements to their mode of work: fluids require a heat proportioned to their

 ſpecific

ſpecific gravity, to boil, evaporate, or diſtil; the loweſt average gravity of their worts, or waſh, previous to fermentation, being ſeldom leſs than thirty pounds *per* barrel when brought together in the fermenting-back: the ſpiſſitude and groſſneſs of this compoſition ſeldom admits of their appearing to be attenuated ſo low as they really are, though it is not often the hydrometer denotes them to be under two, three, or four pounds ſpecific gravity *per* barrel: malting being a ſpecies of attenuation which the whole of their waſh does not poſſeſs, from the quantity of raw corn that they uſe joined to their ſpiſſitude and groſſneſs, induces the neceſſity of a full attenuation in this fermenting back, to prevent that tendency which the particles of unmalted corn has to depoſit a ſediment on the bottom of the ſtill, which inevitably cauſes the empyreuma ſo much complained of in Britiſh malt ſpirits, and which never has yet been completely remedied by ſubſequent rectification; nor can they by any other mode than the means propoſed produce a good article while the exciſe is impoſed by a rate *per* gallon on the waſh, as by any other the very heat neceſſary to diſtil ſo groſs a fluid is alone ſufficient to char it, and induce a burnt flavour: the attemperator for cooling their worts in their paſſage from the under back to the fermenting-back, and for attemperating the fermentation there under all the viciſſitudes of the weather, and changes of the atmoſphere common to theſe climates, and which in ſudden revolutions from cold to mild, or warm weather, are ſo injurious to fermenting fluids; this important utenſil has a multiplicity of applications: for brevity's ſake, and not for want of attention to ſo reſpectable a body

of

of men as the diſtillers are, I ſhall refer them to the earlier ſtages of the brewing buſineſs already enumerated under that head, ſo far as they fall in with their mode of work; fermentation being ſomewhat different with them, inaſmuch as they uſe a portion of raw corn, draw a ſhorter length, uſe no hops, do not boil their worts, make uſe of lob, protract the proceſs of fermentation to a conſiderable length of time, yet rarely can attenuate ſo low on account of the groſſneſs of their waſh, and are conſequently more expoſed to incipient acidity, though leſs injured by it; they are equally nice in the heat and quantity of liquor they turn over each maſh, and not leſs particular in the compoſition of their griſt: fermentation being nothing more than a decompoſition of the fermentable matter and of the water of the fluid; alſo the fixed air or gas formed during the proceſs being compoſed of the hydrogen and oxygen of the fermentable fluid matter and the water of the fluid, alſo there is a perpetual decompoſition and recompoſition of that water which gives fluidity to the whole maſs, and is conſtantly taking place during the continuance of the proceſs, part of the hydrogen and oxygen of which unites and eſcapes under the form of gas or fixed air, for want of a proper intermedium being preſented, of affinity ſtrong enough to abſorb and combine with them into ſpirit. To properly underſtand fermentation we muſt examine into what paſſes during low combuſtion, ſuch for inſtance as ariſes in ſome vegetables, as grain of any kind, new hay, &c. impacted together with the acceſſion of moiſture, heat and motion is generated, which at length breaks out into actual flame; theſe are circumſtances well known to the farmer, maltſter,

and others who are frequently witnesses to their spontaneously taking fire for want of attention in the preparation of the one, and in the making of the other. In all low combustions, as the decomposition of pyrites, respiration, fermentation, &c. there is an increase of temperature above that of the surrounding atmosphere, a resolution or decomposition of the bodies under combustion, and the formation or recomposition of new substances formed out of them by new combinations, in which the following phænomena occur. First, heat is either disengaged or fixed. Secondly, an elastic fluid is either formed or absorbed. These two indisputable facts form the uniform and invariable appearance of combustion, fermentation, and other decomposition. Hence we may define fermentation to be a species of low combustion; fermentation begun in a fluid more or less saturated with saccharine or fermentable matter, the process is finished sooner or later, and usually in proportion to the degree of saturation, and it being conducted with more or less vigour, under a well regulated temperature. First, a portion of inflammable or hydrogen gas is evolved; secondly, another portion of inflammable air, united with a large portion of oxygen gas or vital air, evolves under the form of carbonic acid gas, or fixed air: these are the constant and uniform phænomena of the decompositions, progressively going on from the beginning to the end of the fermentation, while there is any fermentable matter to attenuate. A due proportion of oxygen uniting in a state with a correspondent portion of hydrogen and carbon, forms the spirituous particles dispersed through the fermenting fluid that creates vinosity, and constitutes it wine, beer, wash, &c.

during

during which so great is the avolation of gas or fixed air, that much of the ethereal part of the new formed spirit is carried off in the act of fermentation with it in a gaseous state. This is much assisted by the agency of the atmosphere, which (we have seen) is the solvent and receptacle of ethereal products, whose affinity for them must be as great as it is perfected and immediate, and which demonstrates the necessity of making use of air-tight vessels. The density and quality of the malt-distillers' wash comes nearer to this species of this fermentation or combustion than any we are acquainted with of the more fluid kind; the mucilage of a considerable part of the corn not being previously forwarded to a saccharine state by malting, and though not sufficiently gross to endanger the spontaneously breaking out into actual flame, points out the eligibility of my mode of advantageously expediting the process. The principal object of the distiller being a full and deliberate attenuation of the whole of the fermentable matter, without further regard to the flavour, or any other quality, than strength, vinosity, and spirituosity; as the combining these qualities alone with the production of a clean spirit compleats his *uclios*, which are to obtain the greatest quantity of spirit from a given quantity of materials. The carbonic acid gas or fixed air, which is the constant abundant and uniform result of combustion, and of the vinous fermentation in proportion of 35lbs. weight to every hundred weight of saccharine or fermentable matter, fermented with a due proportion of water, from the decomposition of which last it is partially obtained: for the fully understanding this, it must be understood that the component parts of

one hundred pounds of fermentable matter consists of eight pounds of hydrogen, twenty-eight of carbon, and sixty-four of oxygen; allowing the usual quantity of spirit to be formed during fermentation, the thirty-five pounds of superfluous carbon detached in the process must come from the water of delution and the redundant mucilage and animal gluton of the fermentable matter, the saccharine part of which contains altogether but twenty-eight pounds of carbon; which last must necessarily go to the formation of the seventy-five pounds of alkohol produced from this quantity of materials; this gas in its flight carries off a large portion of the most volatile ethereal part of the half-formed spirit, and a volatile mucilage that should give fulness on the pallate and body to the fluid: to intercept and separate from the gas this ethereal spirit and volatile mucilage, and also to saturate as large a portion of the gas itself with the necessary hydrogen, &c. is among the primary objects of the discovery I have made, and the invented mode of applying the principle as stated in the outset of this my specification; to accomplish which I have contrived a suitable pneumatic apparatus, correspondent to this effect, applicable to those utensils of the brewer, distiller, &c. that are now in use, with the least alteration possible. Allowing the average quantity of fermentable matter in a quarter of malt, barley, or other grain to be seventy-five pounds, then four quarters will be equal to three hundred suttle pounds of raw sugar, or eighty quarters of the one will be equal to sixty hundred of the other, or to three tons weight of unadulterated molasses. If we estimate the superfluous carbonic acid gas of this quantity of materials at only twenty-eight

pounds

pounds *per* hundred, though certainly much more, that will be fifteen hundred pounds diſſipated during the fermentation, which from experiments both analytical and ſynthetical, does not carry off leſs than three hundred and ſeventy-five pounds of ſtrong alkohol, equal to double that quantity of ardent ſpirit at hydrometer proof, which is a loſs on every brewing of this quantity of materials of upwards of forty-one gallons of ſpirits, of the ſtrength of one to ten over proof: what is computed here in ſpirit may be eaſily applied to porter, ale, ſweets, &c. allowing three gallons and three quarters to the former, and four gallons *per* barrel to the latter, which gives eleven barrels and three quarters of the one, and one barrel and a quarter of the other, loſt on eighty quarters of malt, or the average of that quantity of other materials. It muſt appear evi dent to every perſon capable of inveſtigating this calculation that every ſix or ſeven pounds of carbon fixed upon each quarter of malt, or other materials, there will be an augmentation of gravity or ſtrength; on this number of quarters, of ten or twelve barrels each brewing, that is, every ſix or ſeven pounds of this fugitive carbon that we arreſt in its flight, and fix in the fermenting fluid as a component part of the ſubſequent produce by preſenting the requiſite portion of hydrogen, oxygen, &c. within the ſphere of each other's attraction, we increaſe our ſtrength in the before-mentioned ratio. We have preſumed the average quantity of fermentable matter at ſeventy-five pounds *per* quarter, which muſt be evidently on the beſt goods; they will give us a length of three barrels *per* quarter, of twenty-five pounds *per* barrel ſpecific gravity: ſuppoſe the apparent attenuation

attenuation of the produce of theſe goods nineteen pounds, the tranſparent gravity will be ſix pounds *per* barrel: *viz.*

	lb.	oz.	lb.
Gravity of the worts in the cooler juſt before letting down into the gyle-tun			25
Apparent attenuation *per* barrel .	19	0	
Tranſparent gravity *per* barrel . .	6	0	
			25

Or take it as it really is, *viz.*

Specific gravity *per* barrel, . . .			25
Real attenuation *per* barrel, ...	13	8	
Yeaſt and lees *per* barrel, ...	5	8	
			19
Gravity *per* barrel, when tranſparent,			6
Total . . .			25

It may be ſaid, that the real attenuation is nineteen pounds, and that the yeaſt and lees produced as part thereof, as the fluid or beer, in a ſtate of tranſparency, is but 6 lb. *per* barrel ſpecific gravity; and it may be allowed in ſome degree to be really ſo, as there is actually ſo much gravity loſt during the proceſs of fermentation. If we multiply 13 lb. 8 oz. (which I have called the real attenuation) by four, we ſhall find the reſult to be 54 lb. which is 19 lb. more of ſuperfluous gas upon four barrels of worts, of 25 lb. gravity each, than is extricated from an equivalent quantity of ſaccharine matter, that is, 100 lb. of raw ſugar, or 112 lb. of molaſſes, and their reſpective water of dilution, when the yeaſt and

lees

lees do not exceed 5 lb. 8 oz. *per* barrel. This may be truly called an analyſis of the fermentable matter, giving the component parts tolerably exact, though much depends on the management of the fermentation, and the ſubſequent cleanſing with reſpect to the brewer, and equally as much on the fermenting, rouſing, and cutting, of the malt and molaſſes waſh of the diſtiller, the ſteeping and attenuation of the ſweet-maker, the attenuation and acidification of the vinegar-maker, &c. By this analyſis it appears, that the mucilage of the malt or grain gives out more gas than the mucilage of ſugar or molaſſes, which obliges us to adjudge the ſuperfluous gas to the fermentable matter and water of dilution, that is, partly to both; whatever the ſource we derive them from, theſe are the products, and there is no denying facts. The yeaſt at firſt added is not brought into this account. It ſhould be noted, that the animal gluten of grain with which the wheat moſt abounds, has a tendency to putrefactive fermentation, the viſcid mucilage of raw corn to acidity, and the ſaccharine mucilage to vinoſity; and that all the mucilages decompoſed by the low combuſtion of fermentation generate much fixed air, which only can be ſaturated and neutralized into vinoſity by the means propoſed. In the vinous proceſs we have ſeen the eſcape of carbonic acid gas; in the acetous proceſs it is azotic gas, or phlogiſticated air, that eſcapes with more or leſs hydrogen gas, proportioned to the exiſting heat; if the heat is too great, part of the ethereal new-formed acid is carried off in an incipient ſtate.

Vinegar. The ſeveral requiſites for making good vinegar are, a well-fermented vinous fluid, to which

which ſhould be added the ſubſtances capable of farther attenuating it; but my proceſs is not confined to worts; waſh, or other extractive fluids, raw or boiled, that have or have not paſſed through the intermediate ſtate of vinous fermentation, are equally capable, and in ſome caſes more fit to be converted to good vinegar by my proceſs. The carbonic acid gas, ſo abundantly extricated from fermenting fluids during the vinous proceſs, wants nothing but a due portion of hydrogen, and the ſubſequent oxygenation of the atmoſphere, to convert common water ſaturated with it into good vinegar. This being a demonſtrable fact, it is eaſy to conceive, that all or any of the before-mentioned fluids or liquids are convertible, by my proceſs, into the beſt acetous acid, or ſtrongeſt vinegar, by ſimilar means, and the addition of the other elaſtic fluids. Atmoſpheric air conſiſts of twenty-eight parts in one hundred of oxygen gas or vital air, and ſeventy-two of azotic gas or phlogiſticated air, the vital part of which only is the acidifying principle; it muſt be ſo contrived, that as the vital part is abſorbed by the acidifying fluid, the phlogiſticated part, which is rejected, may be let off without carrying with it the fine ſubtile ethereal incipient, and part volatilized, in proportion to the heat naturally generated, or artificially augmented, or oxygen gas alone employed for their oxygenation. The requiſite heat in all ſeaſons can be eaſily procured, and always regulated by the application of my attemperator to the fluids, acidifying either in the ſtove or in the field to any degree of temperature (as before mentioned) between the boiling and the freezing points. The

phlogiſ-

phlogiſticated part of the air of the atmoſphere before mentioned being lighter than the vital part, and alſo lighter than atmoſpheric air, riſes as the vital part is abſorbed, partly by its own levity, and partly from expanſion derived from the temperature of the fermenting fluid above that of the atmoſphere or the augmented temperature excited. The ſtove-chambers and ſowering places ſhould be made air-tight: the preference ſhould be given to warming and heating them with ſteam to a common fire and ſtove-flue, making a circuit with, and returning the flame and ſmoak back into the chimney; the former communicating no bad ſmell, and heating the atmoſpheric air, admitted more uniformly than ſmoak. The ſteam being alſo more convenient for regulating the attemperator, and the attemperature of the paſſing airs, or gaſes neceſſary to flavour, ſtrengthen, and improve, the quality of the vinegar, in conformity to my proceſs. By the compleat lightneſs of thoſe places, the pneumatic apparatus can be as commodiouſly applied to them as to a gyle-tun, cleanſing-vat, fabric ſtore-vat, caſks, or pipes, and the requiſite gaſes injected with as much facility. They can with equal convenience be exhauſted, and the azotic gas drawn out and filtered of the incipient volatile acid mingled with it by conducting it into the pipes, or other veſſels, in the field, or fabric-ſtove vats, where the acid parts are conducted and depoſited, at once augmenting their heat, ſtrength, and acidification. The acidifying-vats or veſſels in the ſtores, &c. may be worked ſeparately, according to their progreſſive forwardneſs or backwardneſs, by means of tubes

through the walls, communicating with the veſ-ſels to be worked, and the apparatus applied and worked without the veſſels being previouſly cloſed up within, that the apparatus may act. Warm atmoſpheric air may be drawn from the ſtoves, &c. for the uſe of the pipes and other veſſels ſouring in the field, or the gaſeous contents of one ſtove transferred to the other, or made to circulate in any manner that the nature of the buſineſs may require.

Moving Rape. Although the moving rape is more applicable to an oblong veſſel, the breadth of which is more than its height and its length, ſeveral times more, with two, three, or more apertures for receiving it at, yet it may be advantageouſly applied to the bringing forward the gyle-wine, acidifying in a veſſel or veſſels of any figure, whether they are fitted up with an attemperator or not. It may be eaſily conceived, that the attemperator employed by the vinegar-maker will be principally for raiſing the temperature of the acidifying fluid, to which it is as applicable as to the lowering the temperature of the fermenting worts, or cooling them in their paſſage from the under back to the gyle-tun.

Impregnators. The gyle-tuns of brewers or vinegar-makers, the diſtillers, cyder and ſweet makers, fermenting-backs, and their reſpective cleanſing-vats, are convertible to impregnators, fitted up with injecting and exhauſting-cocks, and communicating-tubes for the circulating of the fluids they contain during their impregnation with the requiſite gaſes for improving their flavour, quality, and ſtrength. To facilitate the impregnation, inverted cups or hoods, ſuſpended over

over the entering pipe of the injecting-cocks, ſhould be uſed, if not injecting-cocks and organ-valves; or both open pipes and hoods may be applied. When organ-valves are not uſed, if the impregnation is performed on one ſide with the pneumatic apparatus, the fermenting or fermented liquids will circulate on the other as the gaſes or elaſtic fluids are injected, they forcing the contained fluid to circulate up one pipe or tube and down the other. This moſt effectually promoting the impregnation, by bringing every particle of the liquid maſs in contact with the elaſtic fluids, and by their continual action and re-action permanently combine into one homogeneous maſs the component parts of the whole together.

Pneumatic Apparatus conſiſts of a variety of double and ſingle bellowses, of different forms, for transferring gaſes, double and ſingle ſyringes, double, triple, and quadruple air-pumps, of different forms and power for ſimilar purpoſes, and for compreſſing, condenſing, and throwing in two, three, or more atmoſpheres of different airs and gaſes, exhauſting, &c. A variety of different-ſized portable furnaces, gas and air furnaces for imbibing, extricating, generating, tranſferring, and combining, different gaſes and airs; and for converting water and other fluids to ſteam and air, and for paſſing them through different ſubſtances, heated to different degrees of temperatures, for theſe purpoſes. The furnaces conſiſt, or are compoſed of a frame of iron, lined with brick and mortar, and fixed on a wheel carriage, for the convenience of being moved about from one place to another. The bellowses, though

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of different forms, are on the common principle; and the air-pumps, though of different forms and ſizes, are alſo on the common principles, but their application here is totally new; they and the bellowses are placed on carriages with wheels, for the convenience of moving them, like the furnaces, to the different parts of the brewery, diſtillery, &c. but both they and the furnaces may be fixtures, where found neceſſary. The elaſtic pneumatic gas or air-engine is ſimilar in its effects, but diſſimilar in ſhape to a double bellows, conſiſting of any number of cubic feet, ſuited to the magnitude of the work it is to be applied to, calculated to compute the quantity of gas or air made uſe of at any operation. It is rendered portable by being attached to a wheel-carriage, for the convenience of moving it to where employed. The organ-valves are inſerted in rows, circles, &c. of pipes, of that appearance, and act in various directions. The tubes, pipes, and cocks, employed in conjunction with them, alſo act in all directions; the valves in all are placed either in a diagonal, horizontal, or perpendicular poſition, and they, with the inverted cups and hoods, are applied in the manner moſt convenient to the before-mentioned intentions, and are well calculated to avert the preſſure of the ſupernatant fluid. Such are the means by me employed to counteract the influence the changes of the atmoſphere hitherto had on all fermenting and fermented fluids, which moſt effectually obviates the injury ariſing out of that influence on porter, ale, beer, &c. in cooling, fermenting, cleanſing, ſtarting, and attemperating; and at the ſame time improving their

their flavour and quality, and increaſing their ſtrength and preſervation; bringing forward, backing, or ſtaling, recovering when flat, reſtoring when ſour, brightening when gray, fining when foul, &c. In all which intentions the pneumatic apparatus, and the different gaſes procurable thereby, materially aſſiſt, and eventually produce, ſpirit and ſpirituoſity, the one being real, and the other apparent ſtrength, and both exhilerating and wholeſome. And on the worts, malt, and molaſſes waſh of the diſtillers, in condenſing, cooling, fermenting, rouſing, cutting, attemperating, increaſing the purity, ſtrength, flavour, and quality of the waſh, low wines, and ſpirits. And alſo on the worts, gyle-wine, acidifying fluid, fabric, ſtore, and prime ſtore vinegars, of the vinegar-maker, improving their flavour, quality, and ſtrength, in cooling, fermenting, cleanſing, ſouring, attemperating, and in every ſtage of the proceſs; and alſo in the preparation of wines, ſweets, cyder, mead, metheglin, and all other fermentable fluids whatever. Improving their flavour, quality, and ſtrength, in the moſt ſafe, certain, and effectual, manner; promoting diſpatch, ſaving expence, and expediting the proceſs, in each operation of the brewer, diſtiller, vinegar, wine, and cyder maker. In witneſs whereof, &c.

XXVII.

XXVII. *Specification of the Patent granted to Mr.* PETER DAVEY, *of the Pariſh of Chriſt Church, in the County of Surrey, Coal Merchant; for improved Fuel.* Dated May 20, 1800.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that in compliance with the ſaid proviſo, I the ſaid Peter Davey do hereby declare, this my method of making improved fuel is by coking, or in part coking, or cementing, the following, or any other materials, which are capable of being united with coals, by being coked, or in part coked or cemented by fire, in a kiln, oven, or furnace, or in any other way by which heat can be conveyed ſo as to *char or coke, or in part to char or coke, ſo as to cement mixed materials*, leaving a ſufficient ſubſtance in them to anſwer many of the various purpoſes in which it is neceſſary or deſirable to avoid the inconveniences of ſmoak, or the ſmell of ſulphur; that is to ſay: I take the ſmall of the beſt or other ſea-coal, to which I put charcoal or wood, breeſe, turf, tan, ſawduſt, cork, peat, or other inflammable ingredient or ingredients; which ingredient or ingredients are proportioned in quantity to the quality of the ſea-coal with which they are mixed. The ſubſtance or ſubſtances mixed with the ſea-coal are likewiſe proportioned according to the purpoſes for which the fuel is required. For example, if it is deſigned for large fires, for regiſter or other ſtoves, with a powerful draft, a greater proportion of ſea-coal, or the moſt durable materials, is uſed; if to burn in ſmall fires, as in bed-rooms, or inſtead of charcoal, where there

there is but little draft, a greater proportion of the lighter materials is neceſſary. The materials are then well mixed, and put into kilns, ovens, or other furnaces, either dry or moiſtened; and, by means of dampers, ſlides, vent or air holes, or other contrivances, the heat is ſo regulated as to be equal to cementing the materials without deſtroying them. The degree of heat neceſſary to effect my purpoſe, as well as the time required for cementing any given quantity, is known by means of vent or air-holes, or other contrivances, and by the colour and ſtate of the ſteam, ſmoak, or vapour, which proceeds from the materials. The heat and time are not only well ſuited to the quantity cemented at one proceſs, but likewiſe to the quality or ſtrength of the ſea-coal, and the proportions of the different materials; and which proportions, as before mentioned, are varied according to the purpoſes for which the fuel is required. In witneſs whereof, &c.

The Patentee (whoſe buſineſs is carried on at Old Barge-Houſe Wharf, Surrey-ſide of Black-friar's-Bridge,) begs leave to ſtate, that his IMPROVED FUEL is not only found uſeful for chemical purpoſes, and a variety of manufactories, in which it much reduces the conſumption of charcoal; but, by a variation in the proportions of its ingredients, (as above deſcribed,) it alſo is well adapted for drawing-room fires, and other houſhold purpoſes. It ignites freely, burns without ſmoak, and requires no ſtirring. Its price is regulated by that of coals, and is a few ſhillings *per* chaldron lower than the beſt ſorts.

XXVIII. *Specification of the Patent granted to Mr.* DAVID MUSHET, *of the City of Glasgow, in the County of Lanark, Scotland, Gentleman, for his Invention of certain new Processes, and new Modes of employing Processes already known, applicable to Metallurgy, or the manufacturing of Metal or Metals, not only from their Metallic State or States, to the Completion of the various Articles or Utensils usually made, or which may be made, of such Metal or Metals; but also from the State of the Ore into their Metallic State or States, in Bars, Ingots, or otherwise, or immediately into the various Forms, Articles, or Utensils, usually made, or that may be made, of such Metal, or Metals; also certain new Furnaces or Improvements on Furnaces, applicable to the roasting, or preparing of Ores, for the Purposes of Metallurgy, and to the preparing or making of Cokes, and Charcoal, and Mineral and Vegetable Tar, and to other useful Purposes.*

Dated November 13, 1800.

TO all to whom these presents shall come, &c. NOW KNOW YE, that I the said David Mushet, in compliance with the said proviso, do hereby declare that the nature of my said invention, and the manner in which the same is to be performed, is particularly described, and ascertained, in the drawings hereunto annexed, and the following description of them, and of the said process or processes; that is to say: The general principles of my process or processes are the fusion of malleable iron or of iron ore in such manner

ner and by ſuch means as immediately to convert them into caſt-ſteel, and likewiſe in certain caſes the after cementation of this ſteel, to give it malleability, and the property of welding, in order to fit it for ſuch purpoſes as require ſteel poſſeſſing thoſe properties. Theſe principles can be acted upon for the production of the various qualities of ſteel, in a variety of ways; but the principle of my invention, and the mode of operation, may be fully underſtood by the inſtances which I ſhall adduce, and which will enable any perſon to perform the ſame, and to vary and alter the mode of operation, according to his intention, and the particular quality of ſteel he may wiſh to manufacture: thus caſt-ſteel may be made by taking any convenient quantity of malleable iron, according to the ſize of the furnace and crucible or crucibles to be employed, and introducing it into the crucible or crucibles, along with a proper proportion of charcoal, charcoal-duſt, pit coal, pit-coal duſt, black-lead, or plumbago, or of any ſubſtance containing the coally or carbonaceous principle; but in general charcoal, pit-coal, pit-coal cokes, eſpecially if prepared in the manner hereafter deſcribed, will be found to anſwer beſt; for this proceſs not only bar-iron may be employed, but alſo what is commonly called ſcraps or waſte iron; but when the latter is uſed, a little more carbonaceous matter muſt be added to the mixture, to revive the ruſt or oxyde of iron adhering to the ſcraps: the mixture in the crucible or crucibles muſt then be put into a furnace capable of giving a ſufficiently intenſe degree of heat to run down or fuſe the mixture, which muſt be then poured out into bar, ingot, or other moulds, according as the manufacturer intends to

 produce

produce bars or ingots, or various articles, or utenfils that are or may be made of caft-fteel; for the whole iron by fufion, with the charcoal or other fubftances, or things containing carbonaceous matter, will be found to have paffed into the ftate of caft-fteel: if caft into bars or ingots and a proper quantity of charcoal or other fubftances or things containing carbonaceous matter has been employed, fuch bars, or ingots, will be found in a ftate ready to take the hammer, and to be drawn or rolled into other fhapes, according to the intention of the manufacturer: in fome cafes, efpecially where a heavy charge is to be run down, the crucibles muft be previoufly properly difpofed in the furnace, and the mixture introduced into them afterwards by the procefs before defcribed, and which may be varied with circumftances, by any prudent operator. Caft-fteel may be made in a few hours, which by the procefs or proceffes hitherto difcovered has ufually required many days, and fometimes weeks, for caft-fteel by the common method of manufacture has been hitherto made from bar-fteel which had previoufly required for its own converfion into that ftate, from the ftate of bar-iron or fcrap-iron, a tedious cementation with charcoal in a furnace conftructed for the purpofe, and ufually known among manufacturers by the name of a converting furnace; it cannot there efcape obfervation, that this is not the only faving in point of time and expence gained by my procefs or proceffes; for when I meet with or procure iron-ftones, or iron-ores, fufficiently rich, and free from foreign mixtures, I fave even the time and expence neceffary for the converfion of fuch iron-ftone, or iron-ore, firft into caft or pig iron, and

and afterwards by a tedious and expenſive proceſs, accompanied with a great waſte of metal, into bar-iron; for ſuch ore, or iron-ſtones, being previouſly roaſted or torrified, when that proceſs may be found neceſſary, which will often happen, may be ſubſtituted for the bar-iron ſcraps, or waſte iron, as before deſcribed, and the reſult will be caſt-ſteel, if a proper quantity of charcoal, charcoal-duſt, pit-coal, pit-coal duſt, plumbago or black-lead, or of any ſubſtances or things containing carbonaceous matter, had been uſed for the common and ordinary qualities of caſt-ſteel; a much ſmaller quantity of carbonaceous matter is requiſite in the mixture than perhaps would have been ſuſpected, before my invention: when charcoal from wood is employed, a ſeventieth to a ninetieth of the weight of the iron will generally be found ſufficient: when the quantity of the carbonaceous matter or principle exceeds one ſeventieth, and is increaſed from one ſixtieth to one fortieth or more of the weight of the iron, the ſteel becomes ſo completely fuſible that it may be run into moulds of any ſhape, and be capable afterwards of being filed and poliſhed. Hence by caſting may be conſtructed ſtoves, grates, kitchen utenſils, many kinds of wheels, and mill works, a great variety of ſmall machinery, and many other articles which could not be ſo made by the proceſſes now in uſe, and which way of making ſuch articles conſtitutes a part of my invention. By my proceſs various kinds of ſteel differing as much from each other in their qualities as the various kinds of pig or caſt-iron differ from each other, can be formed by merely varying the proportion of carbonaceous matter. Caſt-ſteel of the common and ordinary qualities is ſo

 volatile

volatile when in fusion to admit of being run into any shape except straight moulds of a considerable diameter; but steel of such density as to admit of being cast into any form may be produced by my process, by increasing the quantity of charcoal or matter containing the carbonaceous principle, and then fusing the mixture as before directed. When I wish to produce qualities of steel softer than is usually manufactured by the common processes, I find it best to use a small proportion of charcoal, sometimes so little as a two hundredth part of the weight of the iron: steel produced with any proportion of charcoal, not exceeding one hundredth, will generally be found to possess every property necessary to its being cast into those shapes which require great elasticity, strength, and solidity; it will also be found generally capable of sustaining a white heat and of being welded like malleable iron, and indeed as the proportion of charcoal or other carbonaceous matter is reduced, the qualities of the steel will be found to approach nearer to those of common malleable iron. By further pursuing the principle of my new invention I fuse down malleable bar or scrap iron, in a crucible or crucibles, without any visible addition of carbonaceous matter, and run it into bar, ingot or other moulds; in this state the metal is nearly of the same quality as when put in, only altered by the combination of a small portion of carbonaceous matter which the iron by its chemical affinity attracts from the ignited fuel, or from the ignited carbonic gas of the furnace, and which enters by the mouth or through the pores of the crucible or crucibles, probably dissolved in caloric at a very high temperature: but whether so dissolved or

not,

not, the fact is, that a proportion of the carbon passes from the fire, into union with the iron, and thereby converts it into an extremely soft steel. Besides the different modes of operation above specified, I further reduce iron-ore, bar-iron, or scrap-iron, by the addition of lime, or chalk, or other carbonates, or of carburets with clay, glass, and other fluxes, in various proportions, and form all the various qualities of steel formerly enumerated. If the various kinds and qualities of steel obtained by the process or processes above mentioned, be introduced into the common converting or other steel furnaces, in contact with carbonaceous matter, or with earths, and heated for five days, more or less, according to the thickness of the bars or other forms, and the quantity introduced, the bars, ingots, or other shapes, being then taken from the furnace, will be found to possess all the solidity which they were formerly possessed of as cast-steel, with that property of welding peculiar to blistered-faggot, or German-steel, of the usual mode of manufacture.

By this invention I obtain steel which for solidity may be used for the purposes of cast-steel, uniting at the same time the property of welding without destroying the solidity or quality of the metal, a circumstance of the highest importance to our manufactures. Ingots, bars, plates, and every shape into which this steel is cast, rolled, or hammered, will be possessed of uniformity of quality without those numerous reeds, flaws, blisters, and disjoined laminas, found in steel made by the processes in use before my invention. When pit-coal cokes are to be used in any of the foregoing operations, either in mixture with the ore,

ore, or with the iron, or for fuel in the furnaces, in which the crucibles containing the mixture are expofed to the action of the fire, it is of the utmoft importance that the cokes be properly prepared. The procefs which I have found to anfwer beft for this purpofe, though common cokes will alfo do, is founded upon the principle that all accefs of oxygen to the coals to be coked fhould be prevented; this end is gained by preparing the cokes in iron veffels in the fame manner as wood is now charred for the purpofe of being employed in the manufacture of gun-powder; the bitumens, or coal-tar, as it is commonly called, which is volatilized from the coals to be coked by the heat applied to the exterior of the iron veffel, or other chamber, containing the faid coals, is thus faved, inftead of being burnt or diffipated in the atmofphere, as is the cafe in the common procefs of coaking, in which the coals are expofed to combuftion in open heaps, and which alfo partially, though in a lefs degree, takes place in the procefs, commonly known by the name of Lord Dundonald's procefs for preparing coal-tar; but as it is of importance in large manufactories that the procefs of coaking fhould keep pace with the other proceffes connected with metallurgy, that a fufficient quantity of cokes may always be at command, of an uniform quality, it may be neceffary in many cafes to prepare furnaces fomewhat different in conftruction, but agreeing in principle with the one for preparing charcoal, which has above been generally alluded to. The following conftruction of a coaking-furnace, but which may be varied in form according to the form of the fcite of particular manufactories, and other circumftances, will be found calculated

calculated to produce cokes of an excellent quality; and at the ſame time a ſaving of all the bitumen, or coal-tar, volatilized by the proceſs, and where circumſtances render it adviſable will admit of metallic ores being roaſted at the ſame time, along with the coals to be coked in the interior of the ſtructure, or with ſuch a proportion of coally matter as ſimply to torrify the ores, or iron-ſtones, for the blaſt-furnace.

Fig. 1. (Plate IX.) of the drawing hereunto annexed repreſents an end ſection of the furnace. A, the aſh-pit ſix feet wide at the bottom and narrowing to four feet at the bearer, which is placed acroſs to ſupport the furnace bars. B, the iron bearer. C, the fire-place. D D, the commencement of the flue, which ſurrounds the interior building of the furnace ſix inches high, and two feet broad; of theſe flues there are eight in the length of the preſent furnace, and their number may be extended or diminiſhed in proportion as the furnace is conſtructed of a larger or ſmaller ſize, as theſe flues conduct the flame and heat from the ignited coals upon the grates, the interior part of the furnace and its contents become thoroughly heated. The vapour ariſing from the coals or ores expoſed to ignition, together with the flame and ſmoke of the coals uſed for fuel, eſcape by the aperture E, of which there are alſo eight in the extreme length of the preſent furnace, any greater length of chimney may be added above the preſent, as circumſtances may point out, the ſame apertures may alſo ſerve to charge the furnace. F, a ſmall door in the front of the furnace, which ſerves to empty it of its contents. G, plate of caſt iron which ſerves for the bottom of the furnace, and on which the ſide

walls are built; the under furface of this plate is caft with a number of fmall protuberances, which when covered with a coating of clay keep hold of the fame, and prevent the oxydation of the iron, although expofed to a confiderable degree of heat: in place of an iron plate, an arch of fire bricks on edge may be fubftituted, particularly where there is no fcarcity of fmall-coal or other fuel: inftead of making the fides of fire bricks as reprefented in the drawing, caft-iron plates with flanges may be fubftituted, which will tranfmit the heat with greater facility than brick. (Fig. 2.) top view of the furnace cut acrofs at the fpring of the arch. D D, D D, D D, the fide flues as they rife from the fides of the furnace, to convey the heat and flame betwixt the inner and outer arches. E, E, E, apertures by which the fmoke and vapour, arifing from the fide flues, and from the cavity of the furnace, make their efcape; their dimenfions are twelve inches, and may be either round or fquare; in order to facilitate the ignition of the materials acted upon for diftillation, it will be neceffary in having the furnace to introduce into every fecond flue a wooden plug to reft with its under end upon the bottom of the furnace, which are withdrawn when the furnace is filled. The fire is then laid upon the grates at C, and fed with culm or wafte coals; in a fhort time the cavity of the furnace, or coaker, and its contents become completely ignited, vapour and fmoke are difengaged in large quantities, and carried off through the apertures E, E, E.

Fig. 3. reprefents a furnace of a fimilar fhape, and conftructed upon the fame principles, but which is calculated to collect and condenfe the fmoke

ſmoke and vapour into pit-coal tar, which is volatilized in this new proceſs of charring. A, the aſh-pit. B, the bearing bar, or plate. C, the fire-place. D, D, the ſide flues, as deſcribed in Fig. 1. E, E, flues by which the ſmoke ariſing from the fuel may be eaſily conducted into adjoining chambers, and the ſoot collected for forming lamp-black; this is eaſily facilitated by ſhutting the correſpondent damper at the furnace top, till nearly all the ſmoke has entered the chamber. F, the furnace bottom, an arch of fire bricks upon edge, in place of a caſt iron plate, deſcribed in Fig. 1. G, view of one of the apertures by which the ſmoke and vapour ariſes from the cavity of the furnace, the damper is kept ſhut upon the top of the pipe or chimney H, and the ſmoke is conducted along the horizontal pipe I, and enters the cylinder K, the external cylinder L L, being conſtantly kept full of cold water, condenſes the ſmoke in K, which falling down the internal ſides of the tapered cylinder, iſſues not below, and is conducted by means of a rhone, or pipe, to a general receiver. A furnace of the preſent ſize has eight flues in all, four of which ſerve to conduct the ſmoke of the cavity to the condenſer; the other four are ſimply mounted with dampers, for alternately forcing the ſmoke of the fuel into the vault M, and for admitting the free circulation of air neceſſary to maintain the combuſtion of the grates. In operating with furnaces of this conſtruction, I ſhall remark upon the whole, that, when the furnace without the condenſing apparatus is uſed, the cokes preparing in the interior of the furnace ought to be expoſed ſome hours after the ſmoke had

had disappeared; but the necessary length of time will immediately depend upon the quantity of the coal submitted to be coaked. The same precaution is necessary in using the condensing furnace; for this end all the dampers ought to be opened, and remain so for a considerable space after the smoke and vapour have disappeared. In witness whereof, &c.

XXIX. *Account and Description of an Oven heated without Flues; invented by Mr.* HOLMES, *of Castle-court, Strand.*

WITH A PLATE.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

A Premium of Fifteen Guineas was voted to Mr. HOLMES for this Invention.

OVENS in general use are made with flues, which destroy a great quantity of fire in its passage through them, and much trouble is required to keep them heated. The fire which should be employed in roasting meat is in a great measure dissipated in the flue of the common ovens, if used at the time of roasting, or the common oven does not acquire sufficient heat

heat to anſwer the purpoſe, unleſs much coal is conſumed.

My invention conſiſts of a caſt-iron oven, with a ſolid piece of iron projecting from its ſide into the fire, in which this piece conſtantly remains, and becoming red-hot communicates ſufficient heat for baking to the whole oven.

My oven keeps continually at a baking-heat, without expence or trouble, as the common fire is ſufficient for the purpoſe. The firſt oven, which I made for experiment, was fixed in my own houſe, for uſe, eighteen months ago, and may be viewed at any time. Others are alſo in uſe at Mr. Blackmore's, in Brompton; Mr. Eſdale's, the Banker, in Clapham; Mr. Robinſon's, at Kenſington; Mr. Roe's, at Batterſea; and the Rev. Mr. Wiſe's, at Carlwood; all of which have even exceeded my expectations.

This account is accompanied by letters from ſeveral gentlemen who have had Mr. Holmes's ovens fixed in their houſes, all of whom ſpeak favourably of them. In addition to which a committee of the Society, in order to aſcertain fully how the oven anſwered, ordered two ovens, of ſimilar forms and dimenſions, to be fixed to the ſides of a fire-grate, in the model-room of the Society, one of which ovens only differed from the other by the piece of caſt-iron projecting from its ſide into the fire: both ovens were heated by the ſame fire, and fixed in mortar and brick-work, in a ſimilar manner.

Two loaves, of equal ſize and quality, being prepared from the ſame dough, one was put into each oven; and after remaining therein three quarters of an hour, they were taken out at the

ſame time, and examined. The loaf from Mr. Holmes's oven was in every reſpect well baked, but the other was doughed-baked and imperfect.—An oven upon Mr. Holmes's conſtruction has been ſince fitted up in the Regiſter's kitchen, which appears to anſwer every purpoſe that could be expected from its ſize, which is 13½ inches wide at the door, or in front, and 15 inches deep.

A reference to Plate IX. Figs. 4 and 5, will explain more fully the conſtruction of the oven, and its principle of action.

Fig. 4, a perſpective view of the oven.

Fig. 5, an horizontal ſection of the ſame.

A, that ſide of the oven which is placed next the fire.

B, the projecting piece of iron, which remains ſtationary in the fire, and communicates heat to the oven.

C, the door of the oven.

XXX.

Fig 4.

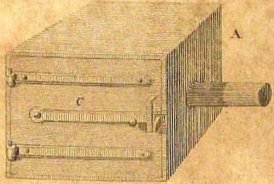


Fig 5.

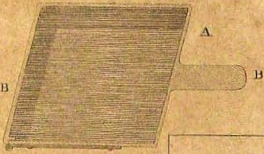


Fig 3.

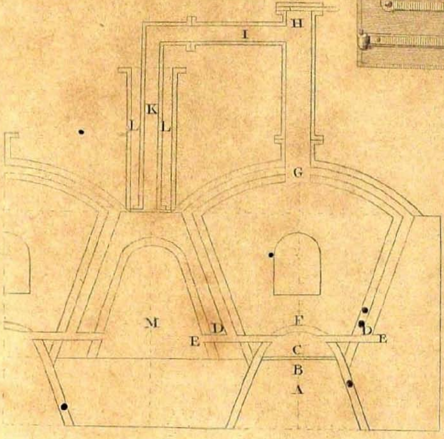


Fig 1

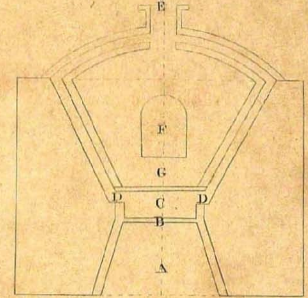
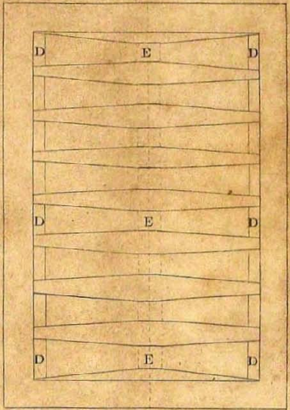


Fig 2.



XXX. *Account of a Diſcovery of a Quarry of Mill-Stones, ſimilar to thoſe known by the Name of French Burrs.* By Mr. RICHARD BOWES, *of Conway, in North Wales.*

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

A Premium of One Hundred Pounds was adjudged to Mr. BOWES's Widow and Children for this Diſcovery.

THE quarry, which I hold from the liberality of J. Sneyd, Eſq. of Belmont, in Staffordſhire, is ſituated within the Corporation Liberties of Conway: the ſtone appears within a quarter of a mile of that town, and extends from eaſt to weſt for the diſtance of two miles, appearing in moſt places upon the ſurface within that diſtance. Such an immenſe body of the ſtone has been left bare, and expoſed to view, that the induſtry of ages would ſcarcely leſſen it. A deep chaſm intervenes at the end of two miles; and, on examining the ſame line acroſs this valley, I find the ſtone mixed up with various other foſſil ſubſtances, to which it ſeems to bear no relation. In the next riſe of mountains it reſumes its quality, and takes a ſoutherly direction, paſſing through a range of hills to the diſtance of two miles more, where the vein diſappears. It is every where the higheſt ſtratum; and, when diſengaged from the quarry where now worked, it tumbles

tumbles down the fide of the mountain to the plain, within five hundred yards of the fhipping-place, where fmall veffels may lie fafely in all weathers, at a natural quay, completely calculated for this bufinefs.

The quarry lies on the decline of a hill: the vein now is about eight yards wide: but we have reafon to fuppofe it is wider below. At the depth we have funk, which is at leaft twenty-five feet, the ftone mends in quality. When firft taken from the quarry it is much fofter, and eafier wrought into fhape, than when expofed to the air; even a day makes a difference. The vein appears to me quite inexhauftible, and contains every variety of the ftone, cellular, clofe, hard, or foft. The right in this tract of country has been prefented to me by Mr. Sneyd, under the hope that I might be able to make this difcovery, and carry it vigoroufly into effect, in which he has not been difappointed. I came into poffeffion on a Wednefday in Auguft, 1797; I fet hands to work the remainder of the day. I had a quantity fhipped on the Saturday, it arrived at Liverpool on the Sunday, and was under manufacture on the Monday morning. In order to entitle me to the premium for the difcovery and application of the Burr-ftone Quarry, I inclofe, for the infpection of the Society, feveral papers to certify the truth of my claim, and to fhow the progrefs I have made. There are two papers from the hands of our clergyman and churchwardens, alfo from the officers of the port of Conway, proving that I have carried the trade to a confiderable extent: this has been done againft the prejudices of a very confined neighbourhood, during the time I was unacquainted with

with their language, and entirely a ſtranger in the country. The money I have expended in this purſuit was the ſaving of a life of labour; and I have no reſource but the Burr-ſtone Quarry, and my own induſtry, for the maintenance of a wife and family. I have alſo a numerous working eſtabliſhment depending upon me for ſupport, which I have drawn together from different quarters.

A pair of mill-ſtones are now in the Society's poſſeſſion, for the inſpection of the public.

The preceding account is accompanied by the following certificates and letter.

We, the millers to Mr. Blundell, at Beverton-Buſh Windmill, do hereby certify, and are willing, if required, to make oath, that we have worked the Welch or Conway mill-ſtone, above four feet in diameter, upon wheat for ſeveral months paſt, in oppoſition to a French ſtone; and, it is our opinion, that it operates on the grain, and produces as good flour as the nature of the wheat wrought upon will admit, and approaches, both in texture and effect, nearer to the French burrs than any we have ever known.

Liverpool, PETER CALAVAL.
December 20, 1799. WM. MYVING.

I, Henry Gardner, mill-wright, and mill-ſtone-manufacturer, do hereby certify, at the deſire of Richard Bowes, that I have manufactured into mill-ſtones about twenty tons of the Conway Burr-ſtone, for the purpoſe of grinding wheat; that five pairs, above four feet diameter, are compoſed of that ſtone only, three pair of which are in actual work; and the principal part of the remainder

mainder of the twenty tons has been intermixed with French burrs in the manufacture of mill-ſtone, it being my opinion that they are a good ſubſtitute for the French.

Liverpool, HENRY GARDNER.
December 20, 1799.

Letter to Mr. RICHARD BOWES.

We comply with your deſire, in noting the preſent ſituation of your cargo of Welſh burr-ſtones, which, ſhortly after landing, we brought home to our own ſtores. The quantity is about forty tons; and we manufactured them into mill-ſtones, with as much ſucceſs as could be expected to attend a new undertaking of the kind, particularly as we were not then acquainted with the beſt mode of making them up: of courſe, as the readieſt method, we put the face of the burrs to the work, inſtead of the ends and edges; this miſtake we have lately rectified, and find ſuch ſtones as have been made on the improved plan will anſwer as well as could be poſſibly wiſhed. Indeed, from the reports of the millers at preſent working the three pair properly made, we have every reaſon to expect, that the importation of French burrs will hereafter be diſcontinued, at leaſt to this part of the kingdom. In the cargo we received one perfect mill-ſtone, with the eye formed: it meaſures at preſent about five feet, and, when rounded for work, may meaſure about four feet ten inches, which is reckoned a large ſtone. We have not yet offered it for ſale, as we wiſh to keep it as a ſample of what your quarry can produce if properly encouraged, as nothing could

could ſhow its ſuperiority over the French more than this ſtone, which comprehends, in one body, at leaſt the ſize of from twenty-five to thirty-three of the burrs we uſually receive from the French coaſt. We have nothing particular to add, but that we have, within the laſt month, procured three very expert hands, who have been uſed to this kind of work; of courſe we expect a few weeks will now complete a freſh quantity, as we have not, at preſent, a ſingle ſtone remaining unſold of thoſe made on the improved plan.

Dublin, EDWARD STEPHENS, and Co.
December 26, 1799.

In addition to the above teſtimonials, the Society have received the following certificates, *viz.* from Mr. Samuel Larigo, of Liverpool, ſtating the opinions of the working millers at that place, that, with proper ſelection in the combination of the mill-ſtones, the Conway are a good ſubſtitute for the French burr-ſtones; and that he had paid duty for fifty tons imported into the port of Liverpool. — From Mr. Robert Heakeſly, of Liverpool, ſtating, that he had purchaſed a cargo of the Welſh burrs, and had manufactured one pair of ſtones above four feet diameter; that he is of opinion that they are of the nature of the French burr-ſtone, and a complete ſubſtitute for that article; that, from every information he could collect, the diſcovery is of conſiderable importance to the public in general, and to the agricultural intereſts of theſe kingdoms in particular. — From Mr. James Lund, mill-ſtone-maker, and Mr. Joſeph Tyrer, millwright, both

of Liverpool, certifying, that they had feen and confidered the nature and appearance of the Conway burrs, and were of opinion, that they are a perfect reprefentative of the French burr-ftone; and that, under fuch impreffion, they had purchafed a quantity, and vefted a fum of money therein for the purpofe of manufacturing it into mill-ftones. — From Mr. Edward Doughty, of Briftol, ftating, that he had received from Mr. Bowes a cargo of Conway burrs, confifting of upwards of forty tons; that, from his obfervation while under the tool, and from the texture of the burr-ftones, he was firmly of opinion they would anfwer the purpofe of French burrs; and that he had been a manufacturer of that article more than ten years. — From Sir Jofeph Banks, noticing, that the certificates Mr. Bowes had produced to him were perfectly fatisfactory, and had convinced him that the difcovery was of confiderable importance to the public.

Mr. Robert Ardlie, of the King's Mills, Rotherhithe, obferved, in a note to the Society, that a pair of the Conway burr-ftones had been worked there ever fince the month of Auguft laft; that on weak ftreams of water, and where they were not required to grind fafter than at the rate of three or four bufhels an hour, they would anfwer the purpofe; but that he was doubtful whether they would be equal to good French burrs.

Mr. Jofeph Jackfon, of the Tide-mills, Liverpool, informed the Society that he had only tried a fingle mill-ftone made from the Welfh burrs, which was a bed-ftone; that the ftone which he worked upon it was a very fine French ftone, and that they anfwered very well together.

The

The committee, to whom the examination of the merits of Mr. Bowes's mill-ſtones was referred by the Society, deſired the attendance of Mr. Fowles, of London-Bridge Water-Works, and Mr. Norton, of Tooley-ſtreet, millwright: theſe gentlemen obligingly waited on the committee, when Mr. Fowles gave it as his opinion, that if a proper perſon was appointed to the ſuperintendance of the Conway Quarry, ſtones would be brought from thence fit to anſwer every purpoſe of the French burrs. Mr. Norton was of the ſame opinion; and farther obſerved, that he had occaſionally purchaſed large quantities of burr-ſtones from France; that the French ſtones differ much in quality from each other; and that, in ſome parts of England, the preference was given to one kind, and in other parts to other kinds. Mr. Norton remarked, that wheat differs in hardneſs and texture, according to the ſoil on which it is produced; that the wheat of different diſtricts, therefore, required ſtones of various degrees of hardneſs and texture to grind it; and the Conway Quarry ſeemed likely to anſwer the purpoſes of the different counties, from the varieties of texture in the ſtone which it furniſhes. He farther noticed generally, that the mill-ſtones, formed from large pieces, are not uſually ſo good as thoſe made from ſmall pieces of ſtone properly ſelected, large pieces being ſeldom uniform in quality. Mr. Middleton, of Lambeth, confirmed Mr. Norton's obſervations on wheat; he alſo produced ſpecimens of French burr-ſtone, which the committee compared with the ſpecimens of Conway ſtone, from which, on examination, they did not appear eſſentially to differ.

A remark has already been made, that the Conway ſtone becomes much harder by expoſure for a length of time to the air. From external marks, it appears to be compoſed of quartz and cherts. It has been obſerved, that the Conway ſtone has been manufactured into mill-ſtones within a few days from the time of its leaving the quarry; and that, even under this diſadvantage, it has given ſatisfaction to the perſons who have uſed it. It is not unreaſonable to conclude, that, by allowing it to harden in the air for the time which intervenes from the ſeparation of the French burrs from their quarry, to their actual uſe in England, and forming the Conway mill-ſtones upon the principle noticed in the letter received from Meſſrs. Stephens and Co. above quoted, they will ſuperſede the uſe of French burrs, and become a great national benefit.

It is much to be lamented, that Mr. Richard Bowes died at Conway in March laſt, leaving a widow and two children, before he had acquired a fortune due to his unremitting attention, induſtry, and merit.

The Society has been lately informed, that Mrs. Bowes is at Conway, and that Mr. B. Chetney, of Newcaſtle, in Staffordſhire, has the late Mr. Bowes's affairs in his hands.

XXXI.

XXXI. *Deſcription of a Pariſh or Family Mill and Bolter for grinding Corn, &c.; invented by Mr.* Thomas Rustall, *Wheelwrihgt, Purbrookheath, near Portſmouth.*

WITH A PLATE.

From the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.

The Premium of Forty Guineas was given to Mr. Rustall for this Invention.

THIS mill promiſes to be of great public utility, as it can be conſtructed at a moderate expence, and ſtands on a ſmall ſpace of ground. It may be worked within a room in a farm-houſe, or even in a public kitchen, without occaſioning much incumbrance.

Its peculiar excellence conſiſts in this circumſtance; that, from the vertical poſition of the ſtones, action may be given to it without the intervention of cogs or wheels: it may be uſed to grind malt, to bruiſe oats for horſes, or to make flour, or for all theſe purpoſes; and it can eaſily be altered to grind fine or coarſe, as occaſion may require.

It may be worked by one man; but if two perſons are employed, it will furniſh, in two hours, a ſufficient quantity of flour to ſerve a family of ſix or eight perſons for a week. The farmer, by allotting half an hour's time in the evening for its uſe, may make comparative experiments of the quality

quality of his grain, and, at a trifling expence, provide himself with flour from his own wheat, without fear of sophistication, or being liable to the caprice or defrauds of a miller.

Repeated satisfactory experiments have been made with this mill before members of the Society; and the original mill is now in their repository, for the inspection of the publick.

A certificate was received with the mill, signed by the minister, churchwarden, &c. of the place, certifying that they had seen the said mill at work, which grinds corn very well, and at the rate of one bushel of wheat within the hour, by the labour of one man and a boy.

References to Plate X.

A, (Fig. 1,) the handle of the mill.

B, one of the mill stones, about thirty inches diameter, and five inches thick, moving with its axis C.

D, the other mill-stone, which is stationary when used, but may be placed nearer to, or farther from, the moveable stone B, by means of three screws passing through the wood block E, which supports one end of the axis C after it has passed through a perforation in the centre of the bed-stone. Through this hole also the grain passes from the hopper F into the mill.

F, the hopper, to which an agitation is given by two iron pins fixed on the axis C, which alternately raise this hopper, containing the grain intended to be ground: the hopper sinks again by its own weight; the corn is delivered by this motion through a spout, passing from the said hopper into the centre of the mill behind, and through the bed-stone D.

G, a

G, a paddle, which regulates the quantity of corn to be delivered into the mill; a greater or leſs quantity of which may be furniſhed by raiſing or lowering the paddle.

H, the receptacle for the flour, into which it falls from the mill-ſtones when ground.

The bed-ſtone D reſts upon two ſupporters of wood, one of which is ſhewn at I: theſe ſupporters are ſcrewed to the block E, and alſo morticed into the lower frame-work of the mill at K: the frame-work is held together by pins or wedges L, L, L, which admit the mill to be eaſily taken to pieces.

M, a fly-wheel, placed at the fartheſt extremity of the axis C. On this fly-wheel another handle may be fixed occaſionally.

N, a ſmall rail, which preſerves the hopper in its place; the fartheſt part of the hopper reſts on a ſmall pin, which admits ſufficient motion for the hopper to ſhake forward the corn.

O, a ſpur rail, to ſtrengthen the frame-work of the mill.

P, the front upright, which is morticed into the frame-work of the mill; this is a reſt for that end of the iron axis C which is next the handle. There is a ſhoulder on each end of the axis, to keep it ſteady in its place.

N. B. A cloth hood, fixed to a broad wood hoop, is placed over the ſtones whilſt at work, to prevent the fine particles of flour from flying off.

Description of the Bolter.

Fig. 2, repreſents the bolter, the front of which is removed, to ſhow its interior conſtruction;

tion; its length is 3 feet 10 inches, its breadth 19½ inches, its depth 18 inches.

A, is a movable partition, which ſlides about four inches backwards or forwards from the centre of the box, upon two ribs of wood, fixed to the back and front of the box, one of which ribs is ſhewn at B.

C, the lid of the bolter, repreſented open.

D, a ſlider, movable in a groove in the lid by two handles on the back of the lid.

E, a forked iron, fixed in the ſlider D: this fork, when the lid is ſhut, takes hold of the edge of the ſieve F, and moves it backwards and forwards on the ribs of wood B, as the ſlider is agitated.

G, a fixed partition in the lower part of the centre of the box, to ſeparate it into two equal parts, in order to divide the fine and coarſe flour; the ſlider A moves about four inches each way from this partition, and thereby gives room for the ſieve F to be worked.

H, a board parallel to the bottom of the bolter, and forming part of the ſlider A. The uſe of this board is to prevent any of the ſifted matter from falling into the other diviſion.

I, repreſents two of the back feet on which the bolter ſtands.

Fig. 3, ſhows the top or upper part of the lid of the bolter.

K, the ſlider, which moves the lengthway of the bolter.

L, L, handles which work the ſlider.

M, a ſcrew holding the fork, which gives motion to the ſieve.

Fig. 4, the forked iron, ſhown ſeparate from the lid.

XXXII.

Fig. 1.

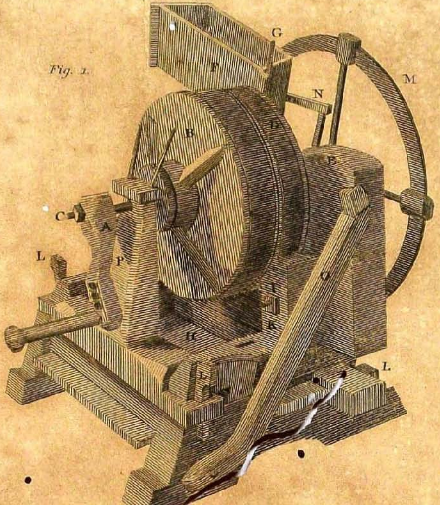


Fig. 3.

Fig. 2.

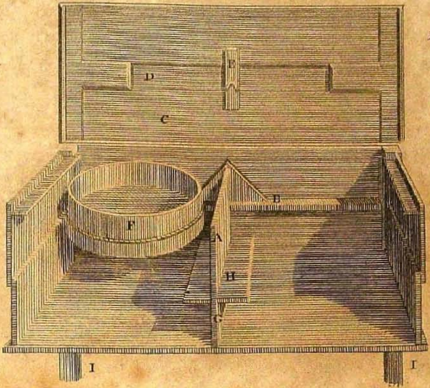


Fig. 4.

XXXII. *Concluſion of Mr.* Proust's *Obſervations and Experiments on Copper.*

(From Page 129.)

IN freſh-prepared hydrate of copper, there cannot exiſt any ſuſpicion of the preſence of an acid, for as potaſh does not ſuffer the carbonic acid to retain its combination with the metallic carbonates, even though it ſhould not be in a perfectly cauſtic ſtate, it would ſtill leſs leave any of the other known acids in ſuch combination.

The complete lixiviation to which the hydrate has been ſubjected, obviates likewiſe all ſuſpicion of any potaſh remaining in combination with it; for 75 parts oxyd, 24 water, and 1 carbonic acid, form collectively a quantity which muſt neceſſarily reduce its proportion to 0 in the quantity of hydrate.

Alcohol, which has ſuch great effect in ſeparating water from ſubſtances that are only moiſtened with it, produces no alteration upon the freſh hydrate that has not yet been hardened by a complete deſiccation.

There cannot be a ſtronger proof of the total abſence of acid in the hydrate, than the extreme facility with which it attacks any acid that comes into contact with it. The acids diſſolve it without effervеſcence, as long as it is freſh and has not been expoſed to the contact of the air.

In order to ſaturate it with carbonic acid, it is neceſſary that it ſhould be diluted with water, and thus expoſed to a current of the acid. Under theſe circumſtances it ſoon changes from the

blue to the green colour, diminishes visibly in bulk, and finally acquires all the characters of a carbonate of copper. It is from the atmosphere, therefore, that the hydrate has received the whole of the carbonic acid that is found combined with it.

In the same manner also, if we plunge it into a saturated solution of sulphate, nitrate, or muriate of copper, it absorbs a sufficiency of acid to change it into sulphate, nitrate, or muriate, with the *minimum* of acid.

Caustic or saturated potash dissolves the hydrate of copper. If we apply an acid to carbonate of potash surcharged with copper, a mixture of carbonate and hydrate of copper is precipitated.

Ammoniac also dissolves it with great facility.

If we mix it with a small quantity of water and muriate of ammoniac, the volatile alkali is exhaled, and the hydrate is changed into muriate of copper with the *minimum* of acid.

I shall conclude these details by drawing the inference, that the hydrate of copper is a real combination in the true chemical sense of the word; and that the water, when it unites with the oxyd, quits its specific heat in the same manner as all other liquids do, when they relinquish the state of mixture, in order to enter into that of combination. In fact, unless the water existed in the hydrate in a condensed state, it could only produce a black wet powder with the oxyd of copper, which, on the other hand, never changes its colour for the green or blue, unless it combines with water.

Finally, the hydrate of copper clears up a difficulty which appeared insurmountable to Pelle-

tier,

tier, when he investigated the nature of the blue ashes, which are nothing more than the hydrate obtained by means of lime. Amongst the facts then known concerning this metal, he could find no explanation of their colours, or, to speak more properly, of a precipitate, in which he could discover neither an acid nor an alkali, to which he might attribute these colours. He found himself therefore reduced to suppose a peculiar degree of oxydation in the copper, for want of paying due attention to other causes in which he might have found the solution of his difficulties.

The hydrate of copper must certainly exist in some of the products of nature; and, in my opinion, we ought to seek it in the native blue oxyds, where it perhaps exists in combination with carbonate of copper, which they appear to contain. Should it not be found in these, we must conclude that this species of ore owes its brilliant colour to some unknown principle, combined with the oxyd of copper; for the green and blue colours are certain indications of a combination of this oxyd, whose degree of oxydation does not otherwise appear to be subject to variation, in its natural state.

Of the Muriate of Copper.

This muriate, when purified and crystallized in spirit of wine, is decomposed by caustic potash, and passes into the state of black oxyd. The following are the proportions of its component parts:

Black oxyd	—	40
Muriatic acid	—	24
Water	— —	36
		100

My estimation of the quantity of acid with which it is saturated, I made by means of the nitrate of silver.

This muriate may be distilled to dryness without undergoing any alteration; but by forcing the heat, a part of the acid passes into the state of oxygenated muriatic acid, whilst the copper, being reduced from 25 to 17 *per cent.* of oxydation, forms, with the rest, a peculiar white muriate, of which I have made mention in my memoir on tin.

Caustic potash produces, with a solution of the ordinary muriate, a green powder; following the same process which we have seen to take place with the nitrate of copper. This powder is a muriate of copper with the *minimum* of acid, if, on the contrary, the potash predominates, the result will be the hydrate.

Caustic potash reduces to 72 of black oxyd the quintal of this green powder, which is insoluble in water. For want of time, I have not as yet been able to determine the quantity of acid which it contains.

When copper is dissolved in aqua regia, a spontaneous separation takes place of a green powder, which is still a muriate with the *minimum* of acid, insoluble in water. The following are its proportions:

Black

Black oxyd	—	79
Muriatic acid	—	$12\frac{1}{2}$
Water	— —	$8\frac{1}{2}$
		100

It has been ſhewn, in a memoir read before the Inſtitute by Darcet, that the native muriate of chili contains the muriatic acid in a proportion inadequate to render it ſoluble in water. I ſhall here ſet down the proportions of its component principles, contraſted with thoſe of the ſand of Dombey, which I have lately had occaſion to examine. They are as follows:

Muriate of Chili.

Copper	— —	$57\frac{2}{5}$
Oxygene	— —	$14\frac{3}{5}$
Muriatic acid	—	10
Water	— —	12
Red oxyd of iron	—	2
Sandy ſulphate of lime		4
		100

Sand of Peru.

Copper	—	46,8
Oxygene	—	11,7
Muriatic acid	—	9,5
Water.	—	15
Sand	— —	17
		100

But as a juſt compariſon cannot be made between theſe proportions, on account of the heterogeneous

terogeneous particles contained in each of theſe ores; I ſhall here reduce them to the quintal, ſetting down only ſuch of their component principles as are of importance in forming the compariſon.

Muriate of Chili.

Black oxyd	—	$76\frac{28}{47}$
Muriatic acid	—	$10\frac{30}{47}$
Water —	—	$12\frac{36}{47}$
		100

Sand of Peru.

Black oxyd	—	$70\frac{40}{83}$
Muriatic acid	—	$11\frac{37}{83}$
Water —	—	$18\frac{6}{83}$
		100

Thus it is evident, that in the ſand of Peru, the oxyd exiſts in combination with a larger proportion of marine acid, than in the muriate of chili. I was at firſt inclined to imagine that this ſand might be conſidered as fragments of the green ore, carried by natural cauſes to a diſtance from the place where it was firſt formed; but on reflecting that by rolling over earths of different properties, and paſſing through water, its proportion of acid muſt neceſſarily have been diminiſhed, I was convinced that this ſand ought to be conſidered as produced from a very different origin.

The habitudes of the ſand of Peru, as well as of the muriate of Chili, with reſpect to fire, are the ſame as thoſe of the ordinary muriate. They

yield oxygenated acid, and white muriate of copper, which poſſeſſes the property of turning green on being expoſed to the air, as the academicians of Paris had already obſerved.

The copper, in theſe two native combinations, as in all the reſt, is oxydated at 25 *per cent.* they therefore immediately form black oxyd when treated with potaſh.

Of the Oxydation of Copper by Means of Fire.

If we apply ſulphuric acid to ſcales of copper prepared expreſsly for the purpoſe, we obtain from them black oxyd in the proportion of 62 parts to 100; the inſoluble reſiduum conſiſting of 38 parts copper in the ſtate of powder.

In like manner I have obtained 36 parts of copper from ſcales procured from the mint of Segovia.

The ſolution, when evaporated, is converted into ſulphate. Now, in every ſulphate of copper, the metal is oxydated only at 25 *per cent.*; fire conſequently oxydates copper in no other manner than is done by the nitric acid, or in the proceſs of making verdegris.

The black oxyd, when fuſed, is of a deep red colour. It is this ſubſtance which ſwims upon the copper in the bath, towards the end of the refining proceſs, and which covers the proofs that are drawn off, as well as the molten copper, with a vitreous ſcum. At the commencement of the refining, theſe proofs are of a dirty blackiſh colour, the oxyd of copper being rendered impure by an admixture of oxyd of iron. But when the whole of the iron has been ſcummed off, and depoſited

depoſited on the ſides of the veſſel, the proofs exhibit incruſtations of a clean red colour.

On the ſides of the reverberatory alſo, red granulated incruſtations are depoſited, which have much reſemblance to the red vitreous ores of copper.

In roaſting the crude copper, the black oxyd is likewiſe obſerved to aſſume the red colour, at the commencement of the fuſion. All theſe oxyds are ſoluble in ſulphuric acid, and return to the ſtate of black oxyd, on being precipitated with the cauſtic alkalies.

Of the red vitreous Ore, or the native Oxyd of Copper.

This ore is found either in irregular maſſes, or cryſtallized. The reſemblance which the laſt-mentioned ſpecimens have with cinabar, or the red ore of ſilver, is ſometimes ſo great, that the one might eaſily be miſtaken for the other, unleſs chemically examined. The province of Coquimbo, in Peru, a country which produces more copper than any other part of the habitable globe, furniſhes this ſubſtance in conſiderable maſſes, which are ſometimes variegated with green and blue incruſtations. This ore, when heated with ſulphuric acid, yields *per* quintal,

Black oxyd	—	—	57
Native copper	—	—	38½
Argillaceous ſand		—	4½
			100

Of

Of the Superoxydation of Copper.

This superoxydation exists neither in art nor in nature. I have myself attempted it by various different methods, but without success. The only fact that could have led me into the erroneous opinion of its being practicable, was the precipitation of gold by the oxyds and hydrate of copper. But, upon considering it more attentively, I discovered that in proportion as the oxyd took the place of the gold in the aqua regia, the latter again separated the oxygene from the gold, which, besides that it combines only with a very small quantity, relinquishes it also with great facility to any other substance capable of attracting it.

Upon the same principle depends also the precipitation of gold from aqua regia by the acetite of copper. The black oxyd, being more strongly attracted by the muriatic acid than the oxyde of gold, compels the latter to deposit itself from a liquid which is no longer capable of holding it in solution, and which moreover deprives it of its oxygene. A farther confirmation of this explanation is afforded by the state of the copper, which, after having been subjected to the action of the aqua regia, is nevertheless not oxydated beyond 25 *per cent.*

The sulphates and nitrates of copper, when well saturated, separate, in like manner, a small quantity of gold from aqua regia; in which case they yield a small portion of their oxyde to the solvent, and hence a proportionate separation of the gold ensues.

That copper has a stronger attraction for oxygene than silver, is a fact of which no one doubts;

doubts; but that the nitric acid has leſs attraction for the oxyd of copper than for that of ſilver, no chemiſt has hitherto ventured to aſſert. Nevertheleſs, if we boil black oxyd, carbonate, and hydrate of copper, in a ſolution of nitrate of ſilver, we ſhall find, that the latter does not undergo the ſmalleſt alteration, or receive the ſlighteſt tinge from the copper.

Hence it follows, that if copper precipitates ſilver from nitric acid, it is only in the direct ratio of its ſuperior affinity for oxygene, compared with that of ſilver — not, as one ſhould naturally have been inclined to believe, in the compound ratio of the ſtronger affinity of copper for oxygene, and the ſtronger attraction of the nitric acid for the oxyd of copper, than for the oxyd of ſilver. It is the ſame with reſpect to the nitrate of mercury: although copper precipitates mercury in a metallic ſtate, the oxyd of copper is, nevertheleſs, incapable of decompoſing the nitrate. Hence it finally appears, that copper cannot become ſuperoxygenated at the expence of gold, of ſilver, or of mercury, metals, which relinquiſh their oxygene more eaſily than any others.

Reſults.

Neither in the operations of art, nor by the hand of nature, is copper ever oxydated but in the proportion of 25 *per cent.* As to the blue and green colours, which have been ſuppoſed to belong to different oxydations of this metal, they are nothing more than the ordinary ſigns of a combination of the black oxyd with ſome other known or unknown ſubſtance.

XXXIII.

XXXIII. *Memoir on the Method of preparing pyrometrical Earths of Wedgwood.*

By Citizen GAZERAN.

FROM THE *ANNALES DE CHIMIE.*

MR. Wedgwood, a member of the Royal Society at London, made known to the public, in the year 1782, a pyrometer of his invention, which consisted of a brass scale, divided into 240 equal parts, and serving to measure the different degrees of contraction, which cylinders, composed of different kinds of earths, experienced, when exposed to the heat of furnaces *.

This instrument is the only one hitherto known, whereby we are enabled to determine and compare the highest degrees of temperature. Its great utility will be apparent, when we consider how much it were to be wished, that, in describing experiments in chemistry and the arts, the degree of temperature employed might always be specified; but as Wedgwood has not acquainted us with the composition of his pyrometers, I thought it would be of advantage to the sciences and arts, to endeavour to discover the process which he employs in manufacturing them.

I shall not enter upon a detail of the investigations and the analyses of the different earths,

* The paper alluded to is inserted in the sixth volume of this work.

 which

which I instituted prior to the principal operations of which I am about to give an account. I begin with observing, that I was obliged to reject all kinds of earth which contained, at the same time, alumine and silex with magnesia, lime and more than one-hundredth part of oxyd of iron.

After having made various mixtures with alumine and pure silex and argil with rock-crystal, or white sand well triturated, I found (conformably to Vauquelin's Analysis of the Pyrometers of Wedgwood) that 25 parts of alumine, 65 parts of pure silex, with 100 parts of water, gave proportions which ought to serve as bases for the compositions which I proposed to make, with a view to produce from the argils of France (which contain alumine in the proportion of 30—40 in 800) pyrometers equal in powers to those of Wedgwood.

The minute and long-continued investigation which I have bestowed upon this subject, from a wish to examine it under a great variety of relations, has even led me to the knowledge of some facts, which would be of the greatest utility towards enabling us to produce porcelains and other earthen-ware, at a price far below that of commerce; but this enquiry I propose to resume at a future period; I now return to my subject.

Of all the different kinds of argil, with which I have attempted to compose pyrometers, I have found the white, which contains the largest proportion of alumine, to be the best adapted for the purpose. That which I used contained, in 100 parts,

Alumine

Alumine	—	—	34,09
Silex	—	—	41,11
Water	—	—	19,25
Lime	—	—	2,30
Oxyd of iron		—	0,75
Lofs		—	0,55
			100,00

Of this argil I took 150 parts, by weight, which I paffed through a very fine fieve: I next added 63 parts of Fontainebleau fand, wafhed and well triturated; and in order that I might have the mixture in the proportions indicated above, I added ftill 200 parts of water. This mixture having been ftirred once a day during three weeks, I kneaded it for the fpace of two hours. The pafte being fufficiently homogeneous, and having dried in the air to that degree that it retained only 30 parts out of the 200 of water which I had employed, I moulded it, in cylinders of tinned iron, into fmall fticks, 15 * millimeters in diameter, and 15 in length, which I compreffed in the moulds, for the fpace of two hours, with the weight of a kilogramme. Having taken them out of the moulds, I put them to dry in a ftove for 24 hours, with a temperature of 40 Reaum. I afterwards adjufted them, as indicated by Wedgwood, fo as to fit into zero of his pyrometrical fcale.

Two of thefe pyrometers, equal in weight (within a centigramme) to thofe of Wedgwood,

* Thus it ftands in the original, but it is evidently an error of the prefs, as the height muft be greater than diameter.

I expofed,

I expoſed, together with two Engliſh pyrometers, in a cloſe crucible, for the ſpace of an hour and a half, to a very high temperature. The two pyrometers of Wedgwood indicated the temperature to which they had been expoſed at 158 and 160, or 159 degrees, whereas my two pyrometers indicated 159 and 160, or 159½; but, as I have obſerved, that the pyrometers of Wedgwood have frequently varied 4, 6, and 9 degrees, from each other, whilſt the variations which mine have experienced have been only from ½ to 1 degree, it follows that the pyrometers compoſed according to the proportions which I have laid down are good, as they exhibited no ſigns of vitrification, after having been expoſed to a degree of heat ſufficient to fuſe iron, and to burſt the beſt Heſſian crucibles.

From theſe experiments, which required a great deal of attention and labour, and repeated trials, it reſults, that if we take an argil, which contains alumine in the proportion of 34 parts, at leaſt, to 100, and add either of rock-cryſtal, or triturated white ſand, or even of pure ſilex, that quantity which the argil requires, in order to form pyrometers equally refractory with thoſe of Wedgwood, its power of contraction will be preciſely the ſame, and produce the ſame effects, as in the Engliſh pyrometers.

XXXIV.

XXXIV. *List of Patents for Inventions, &c.*

(Continued from Page 144.)

STEPHEN HOOPER, of Margate, in the Isle of Thanet, and county of Kent, Gentleman; for his new-invented method, by means of certain machinery, of cleansing and deepening dry harbours, rivers, creeks, &c. part of which machinery may be applied to other useful purposes. Dated December 4, 1800.

JOHN PROSSER, of Charing Cross, Middlesex, Sword-cutler; for a new-invented water-proof pan and hammer, for gun and pistol locks; and also a breech for gun and pistol barrels, for the purpose of a quicker and more forcible explosion of gunpowder. Dated December 9, 1800.

WILLIAM PLAYFAIR, of Great Brook-street, Fitzroy-square, Middlesex, Gentleman, and NICHOLAS LE FARRE, of Still Organ, near Dublin, in Ireland, but now residing in George-yard, Lombard-street, in the city of London, Esquire; for their new-invented improvements in naval architecture, whereby all vessels of all burdens may be enabled to sail faster than they now do, particularly in a heavy sea. Dated December 12, 1800.

JOSEPH EYRE, of Sheffield, Yorkshire, Wood-turner; for a method or process of impressing the japan upon ornamented handles of knives, forks, razors, and other cutlery-ware, made of wood, paper, &c. in imitation of handles made of tip or horn. Dated December 13, 1800.

MARTHA

Martha Gibbon, of King-ſtreet, Covent Garden, Middleſex, Dreſs-maker; for a new-invented ſtay for women and others.

Dated December 17, 1800.

Chester Gould, late of Rome, in the county of Oneida, in the ſtate of New York, but now of Red Lion-ſtreet, Clerkenwell, Middleſex, Merchant; for additional improvements on an inſtrument or log for aſcertaining a ſhip's diſtance, for which he obtained former letters patent in May laſt. Dated December 17, 1800.

James Duxburgh, of Mancheſter, Lancaſterſhire, Calico-printer; for a machine or inſtrument to print diſtant ſprigs or ſpots on calico, cotton, ſtuffs, linen, ſilk, ſattin, cloth, woollen, baize, or leather, in a more complete and expeditious manner than has been hitherto uſed.

Dated December 17, 1800.

John Sharren Ward, of Bruton, Somerſetſhire, Silk-trowſter; for a machine, upon new and improved principles, for the purpoſe of doubling either ſilk, cotton, flax, hemp, worſted, yarn, or other threads. Dated December 30, 1800.

Thomas Grace, of Neat-Houſe, in the pariſh of Saint George, Hanover-ſquare, Middleſex, White-lead-maker; for a method of making an acid for corroding lead, and for other purpoſes; and alſo a new method of preparing and making white-lead, either with or without the ſaid acid. Dated December 30, 1800.

Lawson Hudleston, of Shafteſbury, Dorſetſhire, Eſquire; for a method of conveying boats or barges from a higher level to a lower, and *vice verſa* on canals.

Dated December 30, 1800.

Printed by Nichols and Son, Red-Lion-Paſſage, Fleet-Street, London.

REPERTORY

OF

ARTS AND MANUFACTURES.

NUMBER LXXXII.

Printed by NICHOLS and SON, Red-Lion-Paſſage, Fleet-Street, London.

XXXV. *Specification of the Patent granted to Mr.* THOMAS STATON, *of Caſtle Street Park, Southwark, in the County of Surry, Machine Maker; for his new-invented Apparatus for raiſing Beer, Ale, Wine, Spirits, Oil, or any other Liquids from Cellars, or other low Places, to a higher or more elevated Situation, with more Eaſe and Facility and leſs Expence than any thing ever before invented.* Dated Auguſt 17, 1798.

WITH A PLATE.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that I the ſaid Thomas Staton, do hereby deſcribe my ſaid invention, and declare that the ſame is of the deſcription and to be performed as appears by and according to the perſpective views, geometrical plans, and elevations, of the ſeveral parts thereof hereunto annexed, and as hereinafter particularly mentioned in explanation of the ſame; that is to ſay: It being premiſed, that the principle of my ſaid invention conſiſts in the application of either the

 preſſure,

preſſure, or the elaſticity of air, to the raiſing, or transferring of fluids, I perform, and claim the right of performing the ſame, under, and by virtue of the ſaid letters patent, by the ſeveral means and contrivances, and by the varieties expedient to the application thereof, for ſuch purpoſes as herein and by the annexed drawings ſet forth. A, Fig. 1. (Plate XI.) is a veſſel made of wood, copper, or any other material ſufficiently ſtrong, and neceſſarily air-tight, becauſe it is from the force compreſſed into that veſſel, by means to be deſcribed, that the fluids are to be acted upon; it being eſſential there ſhould be a compreſſion of air in the upper part of the air-veſſel A, ſufficient to overcome the reſiſtance of the fluid, or fluids, to be raiſed: now, in order to produce that compreſſion, or force, the following means may be uſed: B, is a ciſtern of water, placed at an elevation ſuperior to that of the liquor to be raiſed; the pipe R, of lead, copper, or any other material, conveys the water from the ciſtern B, to the lower part of the air-veſſel A, which water may be uſed over again at pleaſure by intercepting the communication of the pipe R at any convenient place, (turning a cock as at Q,) in order that any common pump may act upon, and pump up the water from A, along the ſuction pipe X, X. Fig. 2. Or, as a variety to produce ſuch compreſſion and force, a forcing engine may be uſed to condenſe atmoſpheric air, without uſing water, as in Fig. 2, the pipe C in that figure being the ſame as the pipe C in the drawing preceding, and continued from the air-veſſel A, Fig. 2 being in that caſe made uſe of inſtead of A, B, and R. Fig. 3. Or, another variety to produce a compreſſion of air, to act inſtead

ſtead of that which is ſuppoſed to be contained in the air-veſſel A, may be as follows; L, is a cylinder of wood, metal, or other ſuitable material, to receive a piſton R, of wood, metal, leather, canvas, woollen, or any other proper material, fitting the cavity or core of the cylinder L, and moving therein air-tight; in which piſton is a valve V, opening upwards to admit the air into the cylinder L; the ſaid cylinder L, is provided with a core, likewiſe air-tight, through which works in a collar of leathers, or ſtuffing box, the rod of the piſton R, which muſt be alſo made ſmooth and cylindrical: an aperture is left in the cylinder L, at or near the bottom, below the piſton, for the free admiſſion of air, as at D. W, is a weight of ſufficient power, (to be added at pleaſure, ſo as to overcome the reſiſtance of the fluid to be raiſed, and the friction and weight of the piſton R,) which weight paſſing over the pullies 2 and 3, and connected with the piſton-rod by means of the rope, or chain, S, S, is made to aſcend by means of the windlaſs 1, or any other ſuitable contrivance. The operation of this contrivance being to permit the piſton R to deſcend, and let in through the valve V the atmoſpheric air, then the weight being permitted to deſcend, the piſton is drawn up, the air in the cylinder L becomes compreſſed, and is forced through the aperture of the pipe C, analogous to the pipes C, C, in Fig. 1 and 2. But, although I have ſpecified theſe contrivances, as means of procuring a compreſſion of air, I claim the right of procuring ſuch compreſſion by any adequate means now in uſe and effectual. The application of ſuch compreſſion for the purpoſe of raiſing fluids being ſo above premiſed,

 the

the principle of my invention confidering a compreffion, and force of air, condenfed and obtained, and acting upon, and in the line C C, in Fig. 1, I next proceed to fhew the application of fuch a power to raife fluids for the purpofes fet forth in the title of the faid letters patent: *viz.* the air-cock Z being opened, and a communication formed along and through the main air-pipe CC, a connection is formed, as hereinafter defcribed, between the faid main air-pipe C C, and the cafk to be tapped, fuch communication to be made at the head, or near the top of the cafk, or cafks, intended to be tapped. For this purpofe, a cock made with a male fcrew, as at N, Fig. 4, is fixed to any part at pleafure of the main air-pipe C C, to which by means of a female fcrew as at *g*, Fig. 5, the hawfe G, of leather, lead, or any other fuitable material, may be added, after having been connected with the bung, or ftopper, F, by means of the tube H, which alfo is by a proper fcrew to be added to G; the faid F, Fig. 6, is a bung or ftopper, to be made of brafs, or any other proper material, guarded with leather, and made completely air-tight, which it is neceffary to obferve is very material to the good working of the apparatus in general, but particularly till the liquid has paffed into the main, or delivery pipe, D D, *d d*; the faid ftopper or bung F, has a crofs piece of iron, or any other fuitable material, moving on a joint, fo as to enable it to pafs through the bung-hole of the cafk as at *a a*; the central piece *b*, is a metal fcrew paffing through the bung F, and by means of a nut on the outfide of the faid bung, or ftopper, working upon the faid metal fcrew, the piece *a a*, is drawn upwards, the flanch of the bung F, is forced downwards,

wards, and thus the whole rendered air-tight, and the communication made complete by means of a perforation through the bung F, at H. I have described this as a mode of communication already used, but any communication procured between the main air-pipe and the upper part of the cask, provided it be air-tight, will enable the apparatus to perform its office, by effecting a pressure of air upon the fluid contained in the cask.

Figs. 7 and 8. The figures 7 and 8, are parts belonging to each other to effect a communication between the lower part of the cask to be tapped, and the main delivery pipe, or pipes, D, D, and *d, d. v,* the figure 7, at K, is a tapping cock, which is to be applied to the cock, which is to be applied to the cask, in the usual way of tapping. L, in Figs. 7, and 8, is the same as L, in Fig. 7, and is a hollow plug, or fosset, connected with the hawse or tapping pipe E, made of leather, lead, or any other suitable material, and water-tight. This hawse has a female screw O, which female screw adapted to the male screw N, of the cock N N, in the pipe D D, and *d d,* the plug L, is put or forced securely into the aperture of the tapping-cock K. No. 1, is a cask so tapped; the same letters representing the same parts. The cock N, in the pipes D, D, being then opened, a communication is formed between the liquor in the cask No. 1, and the cocks T, T, at the place of delivery represented as a bar, and which liquor by means of those cocks may be drawn off at pleasure. In this way any number of casks may be made to communicate with the cocks T, T, the lines dotted shewing the course of a communication, which may be opened by repetitions of the

apparatus

apparatus between the air main, and any other casks within the reach of tapping.

But as it may happen that the ordinary butts, or vessels, may be either not sufficiently air-tight, or that they may not be able to bear the pressure necessary for raising, or forcing their liquors up to the required elevation; then I prepare one or more vessels, strong in construction, and air-tight, into which may be racked off the fluid contained in the weaker cask or casks, as in the instances following: *viz.* let the cask No. 2, be regarded as fitted in the same manner as the cask No. 1, and containing liquor, on the surface of which a pressure is thrown from the air main CC, along the dotted lines. Let the casks 3, 4, or any other number, more or less, be the strong and air-tight vessels to be used for the purpose of racking off liquids from other vessels, such as the cask 2. The casks 3, 4, are to be connected with the air main by stop cocks as *i*, *i*, in the head of each of the strong vessels 3, 4, are air or vent cocks *t*, *t*, as described in the marginal Fig. *t*, to admit or discharge the atmospheric air as occasion may require. X, is a pipe, laid and fixed under the level of the casks 3, 4, into which are soldered cocks, and male screws, similar to N, Fig. 4, or N. Fig. 9, making their number as wanted. These are the same as W, in the pipe X. O, Fig. 9, is a female screw, adapted to the male screw N, Fig. 9. *n n*, is a hawse of leather, lead, or any proper material, well fastened to the tapping cock *b*, Fig. 9, which is perforated downwards for the greater convenience of tapping, the hawse *n n*, being screwed to W, the cask 2, or any other within distance, is tapped by entering *b* Fig. 9, then the com-

communication with the air main being opened on the top of the cask 2, and the vent-cocks of 3, 4, marked *t*, *t*, being opened, and the communication of 3, 4, with the air main being shut, and the cocks K, K, or any of them at pleasure being opened, the liquid is transferred, or racked off from No. 2, at pleasure into 3, 4, or any of them, and being racked off, and W being shut, and the air cocks *t*, *t* being shut, and the air main cocks *i*, *i*, and the cocks K, K being opened, the liquor is forced at pleasure from the casks 3, 4, along the tube *e*, *e* into the delivery main pipes D, D, or *d*, *d*, and the effect before described, is produced by discharging the liquors at the cocks T, T, or such other elevations as the pipes are extended to, within the power of the compression produced in the air-vessel. Fig. 10, is a barometer of glass graduated with lines and figures, charged with quicksilver, the tube being recurved to prevent the loss or escape of the quicksilver, and united with a brass, copper, or other metallic tube, air-tight, having a guard, or stop-cock, as in the figure, communicating with the condensed air, in any of the air-vessels. The use of this is to shew by the raising of the quicksilver in the tube, the quantity, increase, or diminution, of compression, and force in the air vessels or cylinder, as the case may be, in order the better to ascertain the force to be applied for raising the intended fluid, which will be shewn on the graduated lines, upon opening the cock of the metallic tube annexed to the barometer. Fig. 11, is a ground plan of the apparatus, and the courses of the pipes already described. Fig. 12, I is a three-way cock, to be fastened on any part of the air-main CC, as at I in Fig. 1, shewing that com-

communications may be made from the air-main at pleaſure. Fig. 13, is a force-pump, to be uſed in certain ſituations, inſtead of the ciſtern lifting pump O, by which the water may be thrown back from the air-veſſel A into the ciſtern B. Fig. 14. This figure conſiſting of the parts, veſſels, and tubes, A, B, C, D, E, explains how a fluid is to be raiſed out of the veſſel E, to the elevation and delivery of the veſſel C, and is as follows: A, is a veſſel air-tight, and of metal, or any proper material, to be exhauſted of its air (the ſtop cock F, being ſhut) by an air-pump, or any other adequate means, (which veſſel A may be made of wood ſufficiently ſtrong to exclude the air by immerging it in a large veſſel of water, which will render it equal to reſiſt the preſſure of the atmoſphere when a vacuum is made in the inner veſſel.) B B, is a tube of metal, glaſs, or other proper material, united to the veſſel C, which veſſel C is beſt to be made of glaſs, in order that its contents may be ſeen. The tube D, of metal or glaſs, air-tight, has alſo a ſtop-cock, or a valve at the lower part of the veſſel, and which is to prevent the return of the liquid into the lower veſſel E. E, is a butt, or veſſel, fitted up with an air or vent cock, as before deſcribed, and tapped at its lower part, as deſcribed in the caſk No. 1, Fig. 1 L, being the tapping pipe for E Fig. 14, as Fig. 8 is the tapping pipe for the caſk No. 1. H is a cock for drawing off the liquor raiſed in C, and G, is a cock for letting in air, to allow the paſſage of the fluid. Now A, Fig. 14, being exhauſted of air, and E, containing a fluid to be raiſed into C, the air or vent cock *i* is opened, as is alſo the ſtop cock F, by the preſſure of the atmoſpheric air on the ſur-

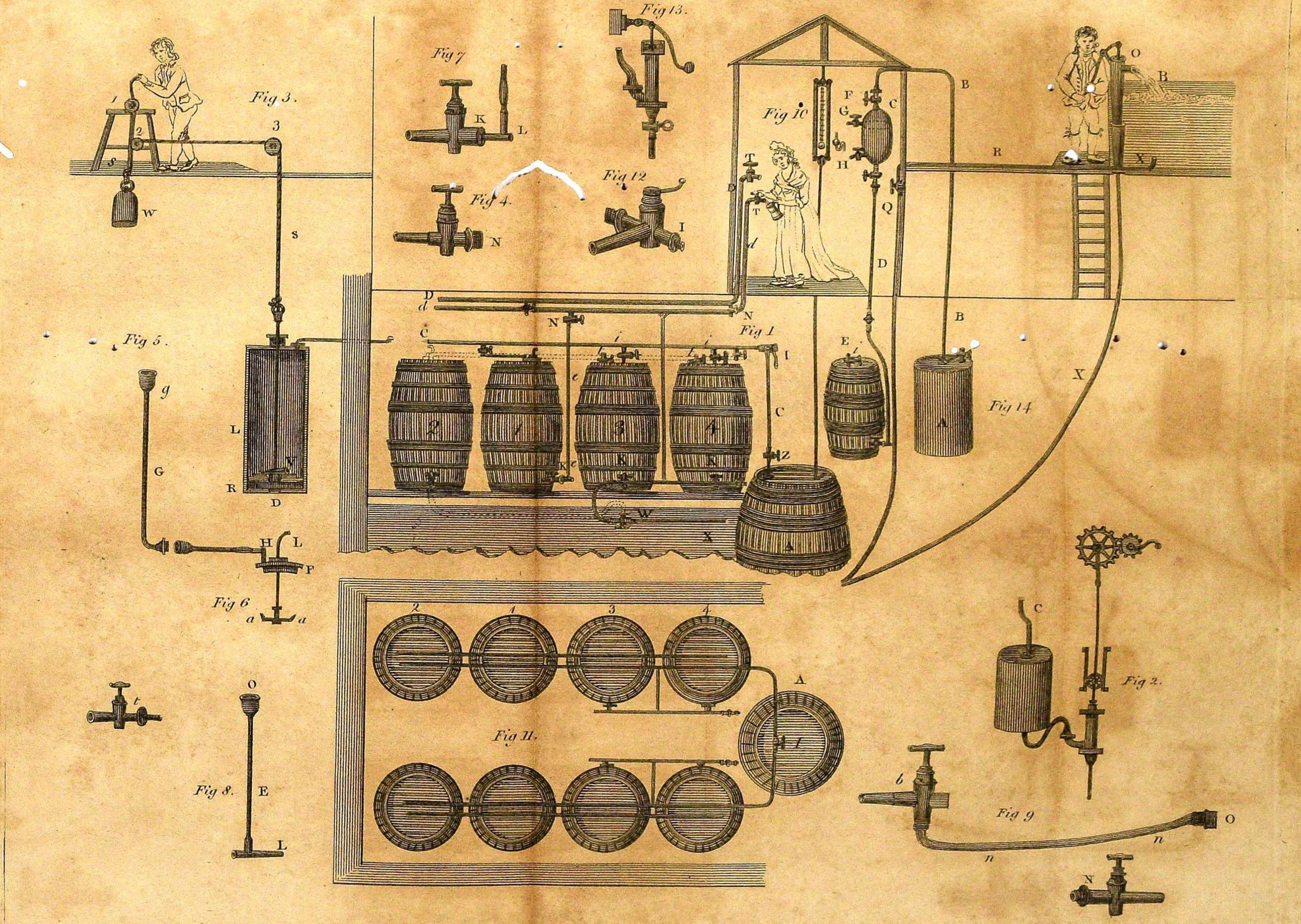


Fig 1
Fig 2.
Fig 3.
Fig 4.
Fig 5.
Fig 6
Fig 7
Fig 8.
Fig 9
Fig 10
Fig 11.
Fig 12
Fig 13.
Fig 14

face of the fluid in E, that fluid is raised into C, and there is intercepted by the under cock or valve; then the cock F being shut, and the cocks G and H being opened, which may be done at one motion, by uniting the two cocks by one spindle, the liquid can be taken from the vessel C, and its supply renewed at pleasure by repeating the means described for raising the fluid in the vessel E, out of that vessel into the vessel C, by means of the tube or pipe D, operated upon through the tube or pipe B B, by the vacuum produced in the exhausted vessel A. But lastly, and principally, my said invention, by the methods before described, raises beer, ale, wines, spirits, oil, or any other liquids, from cellars, or other low places, to a higher or more elevated situation, with more ease and facility, and less expence, than any thing ever before invented. In witness whereof, &c.

XXXVI. *Specification of the Patent granted to Mr.* MATTHIAS KOOPS, *of Queen Street, Ranelagh, in the County of Middlesex, Gentleman; for his Invention of extracting Printing and Writing Ink from printed and written Paper, and converting the Paper from which the Ink is extracted into Pulp, and making thereof Paper fit for writing, printing, and other Purposes.*

Dated April 28, 1800.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Matthias Koops do hereby

 declare,

declare, that my ſaid invention is deſcribed as follows:

1. I cauſe the Engliſh and the German printed paper to be ſeparated.

2. I have all written and printed papers ſorted according to their quality.

3. The paper is to be torn into pieces, and conveyed into an engine to open it gently, and at the ſame time to waſh it quite clean.

4. From the engine it is to be diſcharged into a receiver, where it is to be diveſted of the ſize by means of hot water.

5. It is from the receiver to be conveyed into a boiler, where I take to 336lb. weight of paper 576 gallons of ſoft water, or ſixteen barrels.

Preparation of the Drugs.

A. I add to 11520 gallons of ſoft water 1800lb. of freſh-made quick lime, which muſt be well ſtirred for four or five hours till the lime is totally diſſolved; and, when ſettled, B. I diſſolve, in twenty gallons of lime-water, ſo prepared, 24lb. of American pot-aſh, for the purpoſe of extracting the Printing-Ink from printed German paper, 18lb. of the ſame pot-aſh for Engliſh printed paper, and 10lb. only for written paper.

6. I make the copper which contains the 576 gallons of water and 336lb. of paper boil for half an hour; then I add gradually the before-ſpecified quantity of pot-aſh diſſolved in the lime-water and boil it about two hours longer, when I examine if the ink is ſufficiently looſened; if not, I boil it ſome time longer, conſtantly ſtirring it. When it has boiled ſufficiently I let it re-

main

main in the copper two or three hours to macerate.

7. I then difcharge it out of the copper into a receiver with a double bottom; the upper bottom is of copper, with fmall holes, through which the dirty and oily water drains off.

8. Out of this receiver, pulp muft be taken equal to 140lb. of paper, and put into the wafhing-engine, where it is thoroughly cleaned from the alkali; and in order to brighten the colour muft be added a certain quantity of the following folution, which is to be varied according to the quality and colour of the pulp (that is to fay),

9. I take 150 gallons of foft water and put it in a cafk; 3lb. of marine falt, and 2lb. of black wad, muft then be incorporated and put into a retort connected with the cafk containing the water; to which I add three pints of concentrated vitriolic acid. After properly luting it to the cafk, I communicate heat by means of a fand-bath, and let it diftil for fix hours; after which time the water is fufficiently impregnated.

10. To 140lb. of paper converted into pulp as before ftated, I ufually take from ten to twelve gallons of this folution.

11. This pulp is then to be ground, in order to be made into paper.

Or for Written Paper I ufe the following Method.

1. I take 140lb. of afforted clean written paper and clean it from the fize by means of boiling-water; I then put it into a box lined with copper, the fides and bottom full of holes, which I fix in a prefs and force the water out till the

paper retains no more than its own weight of water.

2. I then put it into a wooden cafe, the infide covered with a thick mixture of white lead and water.

The cafe muft be well luted with pipe-clay; at the back muft be a hole to receive the neck of a retort, into which I difengage gaz made from the ingredients before defcribed for impregnating the water, varying the proportion according to the condition and colour of the articles to be whitened, and from which the writing-ink is to be extracted.

3. I then convey it into the engine to grind it into a fubftance for making paper. In witnefs whereof, &c.

XXXVII. *Specification of the Patent granted to Mr.* JOHN HORATIO SAVIGNY, *of King-ftreet, in the Parifh of St. Paul, Covent Garden, in the County of Middlefex, Surgeon's Inftrument Maker, for his Invention of an Inftrument to be ufed in Surgical Operations, called a Tourniquet, for the Purpofe of more effectually than has hitherto been done, hindering and ftopping the Fufion of Blood in Cafes of Gun-Shot and other bad Wounds and Fractures affecting or befalling the Limbs of the Human Body.* Dated March 31, 1800.

WITH A PLATE.

TO all to whom thefe prefents fhall come, &c. NOW KNOW YE, that in obedience to the faid letters

letters patent, and to the aforefaid provifo or condition therein contained, I, the faid John Horatio Savigny, do, by thefe prefents, particularly defcribe and afcertain the nature of the faid invention, hereby referring to the drawing accompanying and annexed to thefe prefents, and which I explain as follows:

Fig. 1. (Plate XII.) *a*, the upper plate of the inftrument made of brafs, the fides turned downwards to give it ftrength, and to form a frame for the roller *e*. Between the extremity *d* and the fcrew, is an opening for the bandage to pafs through in order to its being ftrongly fewed and fecured upon *d*, whofe edges are rendered perfectly round and fmooth to prevent their cutting through the bandage.

b. A fteel fcrew paffing through a projection in the centre of the upper plate *a*, and fixed by a rivet upon a collar in a counterfink, on the inferior part of *c*, fo as to render it perfectly fecure, and yet to allow it a free rotatory motion.

cc. The lower plate of brafs, ftrengthened in its centre to receive the inferior part of the fcrew *b*, and to form a refiftance to its action.

d. One extremity of the upper plate, round which the fixed end of the bandage is fecured.

e. A roller, over which the bandage is eafily drawn to any degree of ftricture.

f. Three fhort ftrong fharp points of fteel fcrewed into the other extremity of the upper plate to receive and fecure the bandage, when it has been extended over the roller to the defired effect. Thefe points are very flightly curved upwards, that they may move fecurely, retain the bandage when at its utmoft extent of ftricture,

and

and more eaſily diſengage it when the inſtrument is to be removed.

Fig. 2, repreſents the inſtrument of its full ſize, mounted, with its bandage paſſed over the roller; and, though of a very contracted length, ſufficient to explain the nature of its action and effects. This bandage is at leaſt one yard in length, and on its free extremity is rivetted a ſmall triangular piece of thin plated metal, which, by giving it a proper fixed curve, will enable it, on application of the inſtrument, to paſs more readily through the opening in the upper plate, between the roller and the ſcrew.

Fig. 3. A compreſs of cork covered with leather, having on its flat ſurface, at each extremity, a loop ſewed acroſs, by which it is always retained in a longitudinal poſition upon the bandage, and ſlides upon it till fixed at any deſired point.

N. B. This compreſs is not always neceſſary, as the bandage, by the power of the inſtrument, is of itſelf ſufficient to ſtop ſudden hæmorrhages from violent wounds till chirurgical aſſiſtance can be obtained. In operations, indeed, it is indiſpenſable, as making a more forcible and immediate compreſſion upon the artery.

The conſtruction of the inſtrument, as to its uſe, is ſo ſelf-evident, that very little inſtruction is neceſſary in this particular. When the bandage is applied round the limb, it is to be paſſed through the opening behind the roller, drawn over it as tight as poſſible, and ſecured by fixing it upon the three ſteel points. In many inſtances this will be found ſufficient; but if, in ſome, it ſhould not, a few turns of the ſcrew effectually complete the intention. In witneſs whereof, &c.

Fig. 1.

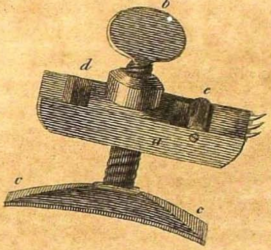


Fig. 2.

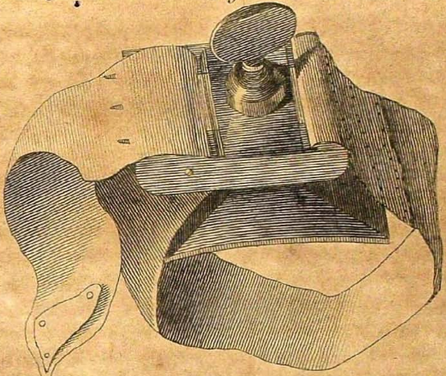
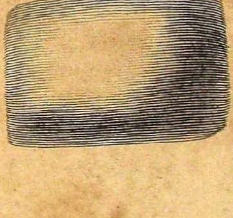


Fig. 3.



XXXVIII. *Specification of the Patent granted to Mr.* JOSEPH HUDDART, *of Iſlington, in the County of Middleſex, Eſq. for certain Improvements in the Tarring and Manufacturing of Cordage.* Dated July 1, 1800.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that in compliance with the ſaid proviſo, I, the ſaid Joſeph Huddart, do hereby deſcribe and aſcertain the nature of my ſaid invention, and the manner in which the ſame is to be performed, as follows; that is to ſay: In my ſpecification for improvement in rope-making, by regiſtering the ſtrands and thereby acquiring greater ſtrength by a proper ratio between the length of yarns and more equal diſtribution of the ſtrain, inrolled under letters patent, granted me on or about the 25th of April, 1793; and alſo, by performing the regiſtering in a more convenient way by a machine deſcribed in the ſpecification of other letters patent, granted me on or about the 20th of Auguſt, 1799 *; a conſiderable expence is attached to having the tarred yarns wound upon bobbins; and alſo the tar (eſpecially when the rope is laid in cold weather) is not ſufficiently incorporated amongſt the yarns to render it compact for durability, whether regiſtered or laid in the common way. In order to obviate thoſe inconveniences, I have invented a method of regiſtering the ſtrands of ropes or cordage during the operation of tarring the yarns, which may be effected in the following manner;

* Publiſhed in Vol. XII. of this Work.

manner; and theſe are the improvements which I am now to ſpecify, according to the proviſo above recited, that is to ſay: the white yarns intended to compoſe the ſtrand muſt be wound ſingly upon reels or bobbins, and placed upon a frame, or otherwiſe, ſo that the yarns may be delivered from them with as ſmall and equal a tenſion as poſſible, and to paſs under rollers, or through holes, or between ſeparating rods of wood or metal to be guided into the tar, (when ſufficiently heated in the kettle), and from thence to the regiſter, ſeparate from each other, to prevent entanglement until they enter the tube. This regiſter and tube has been particularly deſcribed in the ſpecification to my firſt-mentioned patent, to which I beg leave to refer.—It muſt be placed near the oppoſite end of the tar-kettle to that where the frame of bobbins are which contain the white yarns. The regiſtering tube muſt now act in a double capacity, *viz.* to form the ſtrand fair and free from cockling, as in the performance of regiſtering, and alſo as a nipper to force out the ſuperfluous tar, which may return into the kettle. The tube deſcribed in my laſt-mentioned ſpecification will anſwer the intended purpoſes, or it may be made in two parts to compaſs the ſtrand more uniformly, as it may vary in its ſize by the action of a ſpring or weight, &c. The ſtrand being drawn from the bobbins, and paſſing ſeparate through the tar and regiſter to the tube or nipper, muſt there receive a proper turn to form the angle in regiſtering, and give the required ratio to the yarns in the ſtrand, which is moſt accurately performed by the regiſtering machine deſcribed in the ſpecification and drawings to my laſt-mentioned patent, to which I alſo beg leave

leave to refer. But the turn or twiſt in the ſtrand between the tube and machine will continue to force out more ſuperfluous tar (being ſtill warm and fluid) to the ſurface of the ſtrand, which muſt be cleared off by another preſs or nipper. This may be done by ſurrounding the ſtrand by hemp cloth, or any other ſoft ſubſtance; but I have found the nipper-plates (which, being uſed in common, need no farther deſcription), that form a circular hole the ſize of the ſtrand, and allow compreſſion, as may be found requiſite, will beſt anſwer the purpoſe. The ſtrand when thus tarred will contain a leſs ratio of tar to the quantity of hemp in the yarns, than when tarred in the haul by the uſual method, unleſs more time is allowed for the tar to eſcape at the nipper; and yet the ſtrand will be ſufficiently tarred is evident from the tar oozing out at the ſurface of the ſtrand between the tube and laſt-mentioned nipper, which finiſhes the tarring and regiſtering of the ſtrand, and may be laid into a rope after hardening up to the required angle in the ground by the common method. Note, in compactneſs, durability, and in preventing the water from penetrating into the ſtrand (to attain which is the intention of tarring), I conceive my preſent invention is an improvement upon all the modes hitherto in uſe. The tar-kettle muſt be ſufficiently long to allow the yarns to be thoroughly ſaturated with tar during their paſſage through it; and it will be a farther improvement to fit it with a head-flue, and a damper in the flue, to retain the heat and evaporating matter flying off ſo quickly, which renders the tar pitchy, or too hard for the intended purpoſe, when the operation is carried on or continued for a length of time.

 A ther-

A thermometer ſhould be uſed to ſhew the heat of the tar; for, if too high, will tender the yarns, which has too often been the caſe by the common method of tarring. I have alſo invented a friction-block, or clutch, which may be uſefully applied to various parts of machinery, as wheels, riggers, &c. when a heavy body is required to be put in motion, or the contrary, without ſtopping the power, or in communicating a part of the motion. This invention conſiſts of a hoop of metal cut open at one ſide, but nearly ſurrounding a cylinder of wood or metal, which is fixed upon either of the revolving axles, between which it has to communicate a motion. The open part of the hoop is connected by a ſpring to draw or tighten the hoop round the cylinder, and a ſcrew to increaſe the force of the ſpring. At near one end of the hoop it muſt be pinned or ſecured to the wheel, rigger, &c. and give motion to it by friction between the hoop and cylinder; the wheel, rigger, or clutch, being at liberty to move round upon the axis or cylinder, can only be carried by the above friction; and, in order that it may act more uniformly, that end of the hoop muſt be pinned to the wheel, &c. which, by the working, will tend to open the hoop; or againſt the action of the ſpring, being contrary to the fixing of a curb to ſtop a windmill: for the intention is not to clamp, or to be too rigid, but to apply a required force to be regulated by the ſcrew and ſpring. I have applied it to the rigger of the regiſtering machine which carries the reel to prevent the rubbing of the band round the riggers; or a ſhaft may be applied to carry the reel with the deſired force by this invention. In witneſs whereof, &c.

XL. *Ac-*

XL. *Account of a Method of forwarding Vegetation, by Means of Steam.* By Thomas Wakefield, *Esq. of Northwich.*

WITH A PLATE.

From the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.

The firſt experiments were made in a ſteam-houſe invented by Mr. Wakefield; the ſubſequent ones are copied from a Diary written by Mr. Butler, when Lord Derby's gardener, and were made in a ſteam-houſe built at Knowſley by Lord Derby.

In the year 1788, about the beginning of April, Mr. Wakefield being diſappointed in ſeveral endeavours to procure bark for a crop of melons in a Dutch pit, twenty yards in length and three in breadth, thought he might contrive to heat it by ſteam; and that, if he could ſucceed, he ſhould ever after ſave the great trouble and expence of getting bark in the neighbourhood of Liverpool. In a few hours, in the preſence of two or three friends, he made a plan of the flues, arch, &c. according to the preſent method, and was then ſo confident of its ſucceeding, that he ſent for workmen the next morning; and, in a few days, under his direction, the pit was altered and fitted for the ſteam method.

From Mr. Wakefield's Diary.

Experiment I. Commenced on the 25th of April, by putting ſome good melon plants into

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three feet deep of ſtrong melon ſoil. The plants grew very well, and were remarkably ſtrong and luxuriant, but ſet no fruit till the 25th of July; they then produced an abundant crop, excellent in flavour, thin-ſkinned, and thick-fleſhed. It is now clearly proved, that their extreme luxuriance and backwardneſs in ſetting their fruit, was owing to the depth of the ſoil, as will be ſeen in the following year's experiments. It holds good in the fruiting of plants in general. Small pots will throw pines into fruit. Trees planted in deep ſoil, particularly pear-trees, are a long time before they fruit.

Experiment II. 1789.—Suppoſing that laſt year's ſoil was too rich, I planted this year in the ſame depth of a weaker ſoil, with a conſiderable addition of good clay marl, but leſs dung; thinking I ſhould prevent, by this mean, the vigorous progreſs of the roots: but from the prodigious vegetating power attending this method, the plants grew equally luxuriant. Still they had no propenſity to ſet their fruit until about the ſame time of the year: the crop was again abundant and excellent. It was no uncommon thing for the fruit to grow in cluſters of two and three, ſimilar to walnuts; and univerſally each melon of the cluſter ripened at the ſame time, and came to its full growth. Every thing is nearly the ſame as laſt year.

Experiment III. 1790.—As I now began to imagine that the depth of the ſoil occaſioned the great luxuriance of the plants, I reduced it to two feet in depth. In conſequence of this, the plants ſet ſooner, but ſtill late, and were too luxuriant. They produced, however, a moſt excellent crop, as well as in the former years.

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Experiment IV. 1791.—Being now convinced of the neceſſity of not having the ſoil too deep, and wiſhing to aſcertain the beſt depth, I filled the large pit with ſoil in ſuch a manner as to have a regular ſlope from end to end: the deepeſt part was two feet and a half, and the other one foot. The reſult was curious and intereſting; for the fruit in the different lights ſet in regular ſucceſſion, week after week, thoſe plants fruiting firſt in the ſoil of one foot in depth. The crop was abundant; and on the deepeſt part of the ſoil every thing was nearly as in the former years.

Experiment V. 1792.—This year the melon-plants were planted in fifteen inches of ſtrong melon-ſoil, upon two feet of bark, that had been uſed two years before in the ſame pit, to prevent the ſteam from acting too powerfully on the ſoil, and to raiſe the plants near enough to the glaſs. All now ſucceeded well. The fruit ſet as well as on bark or dung, but was infinitely more luxuriant and productive.

During the laſt five years, the ſteam has been abundantly uſed in Mr. Wakefield's vine-houſe, with a ſucceſs beyond his expectation. The firſt year the ſteam was uſed, the vines were much more luxuriant, and grew at leaſt a month longer than formerly: to this circumſtance the abundant crop of fruit the year following was in a great meaſure attributed, as it afforded time, after the fruit was gathered, for the embryo fruit to form in the buds for the enſuing year. Till now, it has been found difficult to furniſh the plants with ſufficient nutriment, both to ripen an abundant crop of fruit, and to ſwell the buds to that degree which is requiſite to ſecure a good crop for the

the ensuing year. Through a want of this power, it frequently happens that vines, as well as other plants, seldom produce abundant crops for two successive years: but, by the present method, Mr. Wakefield's vines have produced, for the last four years, fruit in the greatest abundance, and of the best quality; the grape-berries being much larger than formerly, thinner skinned, and better flavoured. But a sufficient proof that the vine delights in this atmosphere is this, that if steam be sufficiently supplied during the whole of the summer, the leaves every morning will be pearled round the edges with drops of water exuded from the plant. This is frequently seen in every house during the spring, when the earth and the atmosphere are charged with moisture, for then vegetation is in the most luxuriant state. But this indication of vigour is never seen at any other season in the old method; and, from the want of it, the red spiders too frequently make their ravages, though, when steam is given in sufficient quantity, that destructive insect is never seen.

FROM MR. BUTLER's DIARY.

A periodical Account of Experiments made in forcing esculent Vegetables by means of Steam, with their Success, as practised in a House erected for that Purpose at Knowsley, 1792.

Sept. 13.—Laid the foundation of a steam-house, forty-two feet in length, and twenty-two feet in width; the back of which is in height fourteen feet, the front five feet six inches, and the

the ſurface contains nine hundred and twenty-four feet.

I have generally found, that, in well-conſtructed pine-houſes (if not very much expoſed), one fire is allowed for every four hundred ſquare feet; as leſs than this, in very cold weather, would be inſufficient to maintain a proper degree of heat, without making the flue too hot, and thereby generating a deſtructive atmoſphere. If a greater number of fires were allowed, they would probably, in unſkilful hands, or when left in the night, over-heat the stove. My reaſon for the extra one hundred and twenty-four feet to two fires (the number this houſe contains), was either to prove to a certainty that leſs fire is required by uſing the ſteam than in the old method, or to be practically convinced that the contrary is true.

Jan. 1, 1793.—Sowed ſome cucumber ſeed of the Southgate long prickly kind in a one-light frame, placed on a dung bed, not only to raiſe plants for the ſteam-houſe, but alſo to ridge out on dung, to be treated according to the Southgate method, being the moſt approved and expeditious method hitherto known of raiſing cucumbers. The bed being in fine order, the ſeed quickly vegetated, and grew very faſt. They were alſo fit to ſtop, having thrown out two rough leaves by the time the houſe above-mentioned was finiſhed, which was the 1ſt of February.

Experiment I. Feb. 1.—This day ridged out ſix holes or lights on a dung-bed, it having been in preparation three weeks, and put twenty holes in boxes in the ſteam-houſe, placing them on the dry flue, in the back of the houſe. Alſo planted ſome French beans in pots, and placed ſome roſes,

roſes, pink carnations, and hyacinths, in pots, on the kirbs and pit.

Succeſs of Experiment I.—Cut a handſome fruit on the 28th of February, being eight weeks and three days from ſowing the ſeed, and four weeks from the plants being firſt brought into the ſteam-houſe.

Feb. 3, 1793.—Found that the cucumber plants ſtanding on the flue did not anſwer. Placed ſome of them on a ſhelf cloſe to the back wall, being two feet from the glaſs, and alſo placed others on the ſurface of the pit.

The quantity of water evaporated the laſt night was twelve gallons. Found that this was rather too much, the plants being very wet, and dropping from the glaſſes very faſt. The mercury in Fahrenheit's thermometer was, in the morning at ſeven o'clock, 64 degrees. A ſimilar thermometer, plunged into the old bark, roſe to 100 degrees. This is a very kindly heat for tan.

Feb. 6, 1793.—The plants of cucumbers look exceeding well; thoſe on the ſhelf and thoſe on the bark keeping pace with each other. The runners puſh on with a vigour and regularity I never before witneſſed. The leaves are unuſually dark; and on the ſhelf ſome fruit are ſhowing.

The French beans are appearing very uniformly through the ſoil.

The roſes vegetate in a manner truly aſtoniſhing. It is uſual to ſee them, in the common method, break only from one eye, which is generally that at the extremity, while the reſt remain dormant; but here every bud ſeems to be eager for the lead, and, as in a kindly ſhowery May, promiſe a profuſion of flowers. The pinks are beginning to ſpindle; the carnations not much;

 but

but the progreſs of the hyacinth is wonderful. Quantity of water evaporated, ten gallons. Night thermometer, 66 and 101 degrees.

Feb. 8.—Cucumbers ſtill grow rapidly. Thoſe in the frames look as well as they generally do, but are by no means equal to thoſe in the houſe. The progreſs is by no means equal; thoſe in the houſe, with ſteam, growing as much in twenty-four hours as thoſe in the frames in forty-eight hours.

Experiment II. Brought in this day one cherry-tree, one peach, one apple, and a vine-bud. The cherry, peach, and apple, were maiden, or one-year old, from the bud or graft the laſt February, viz. 1792, being a May-duke cherry, a Royal George Peach, and a Nonſuch apple, in pots. Theſe were placed on the kirb of the ſtove. The vine had made about three feet of wood the preceding ſummer, and nearly the ſize of a quill: I put it into a pot filled with one half rotten turf from a loamy ſoil, one third rotten cow's dung, the remainder ſand; the pot was eighteen inches over, and twelve inches deep. At the ſame time I headed the vine down to two eyes.—Brought in a pot of myrtle, geranium, and jeſſamin cuttings, and plunged them into the old bark.—The roſes, &c. grow very ſtrong and rapidly.

Quantity of water evaporated, ſixteen gallons, or thereabouts. Thermometer ſuſpended in the houſe, 68 degrees.

Feb. 14, 1793. On the 12th ſowed ſome cucumber-ſeed in a pan, and plunged it into the bark. Cucumbers ſtill aſtoniſh me with the progreſs which they make—ſhew plenty of fruit.—Brought ſome potatoes into the ſteam-houſe—

roſes ſhow a great many buds—hyacinths and pinks come forwards very faſt—peach, cherry, and apple do the ſame—ſome cherry bloom ready to burſt out.—I found the plants rather too wet this morning, ſo only gave nine gallons, or thereabouts, to be evaporated this night.

Feb. 16.—Every thing going on well—firſt cucumbers came into bloom. Thermometer 67 degrees.

Feb. 17.—Peach, cherry, and apple, in full bloom—every thing elſe going on well—cucumbers ſowed the 12th finely up—thoſe firſt brought in, ſhow plenty of fruit-bloom.

Feb. 23.—Cherry-tree bloſſom falling off, being evidently too hot—about a dozen ſet, but are evidently in too confined an atmoſphere, wanting more air than the other things in the houſe.—French beans remarkably vigorous—potatoes coming up very fine: roſes and other flowers look remarkably vigorous, as alſo cucumbers. The peach and apple bloom looks very fine. The cucumbers, in common frames, do very well, but are much behind.

Water evaporated about ten gallons each night. Thermometer, from 66 to 70 degrees.

Feb. 28.—Cut firſt cucumbers in ſteam-houſe, being ſeven inches long, having been twelve days in bloom, twenty-eight in the houſe, and fifty-nine from ſowing the ſeed. Cherries all turn yellow, and drop off—apple bloom does the ſame—too hot for them.

Peach does pretty well—every thing elſe ſtill aſtoniſhes me with the rapidity of its growth—leaves of French beans and cucumbers highly beautiful—look as though they were in their true

element

element—ſome of them are fourteen inches long, and as black as a hat.

March 1.—Every thing growing with a rapidity truly wonderful.

Water evaporated eighteen gallons each night. Thermometer, 68 to 73 degrees.

March 5.—Cut cucumbers, ſome of them eight inches and a half long: thoſe in the common frame look very well—ſhow fruit, and have two ſet.

The peach-tree has a great quantity of fruit ſet on it, which look remarkably well, and are free from inſects.

Experiment III. March 8.—Brought a great quantity of pine-ſuckers of laſt year—having diſrooted and plunged them into old duſt of bark, being the ſmall bark riddled out of the old ſtoves.

Cut eight cucumbers, ſome of which were ten inches long—hyacinths, narciſſuſes, and jonquils, in fine bloom.

March 10.—Gathered firſt French beans, being remarkably fine. The quantity of cucumbers, in their different ſtages of growth now on the vines, is almoſt incredible: the plants are vigorous beyond deſcription. Indeed this is the caſe with every thing in the houſe. No inſect yet appears; the thrip is not even on the French bean over the entrance of the dry flue.

Water evaporated, eighteen gallons per day.—Thermometer, 68, 70, and 73, by night; but by day 80, 90, and 100—when plunged into the bark, 105 conſtantly.—A fine heat—gave a little air every day about ten o'clock, if the wind is not high, and there is no rain.

March 15.—Every thing ſucceeds, and anſwers my moſt ſanguine expectations. Turned out a pine plant; find it has got a fine root quite to the outſide: the pot pines look remarkably well—ſuffered leſs from loſing their roots than in the common mode of treatment. Cucumbers ſown in this houſe as fine as thoſe raiſed on dung.

Cut firſt-fruit in the common frames, being fifteen days behind the ſteam. The plants have received no check, and look very fine: ſix weeks and one day have elapſed from ridging out, and ten weeks and four days from the ſowing the ſeed.

Water uſually evaporated is about twenty gallons, if a fine night and dry with wind; but if wet and cloſe, ten or twelve will be found ſufficient for a houſe of this ſize.

March 18.—Find the bark growing too hot for the pines—raiſed them half the depth of the pots out of the tan.

March 20.—Every article before enumerated doing well; obliged however to give over much ſteam, as the bark, although ſmall and ſolid, is heated to a greater degree than I ever knew any ſuch ſubſtance to be heated. The quantity of cucumbers now cut from this houſe is aſtoniſhing; ſome to the length of eighteen inches.

March 25, 1793.—Heat in the bark ſtill continues very violent, although the ſteam has been diſcontinued ſince the 20th. The peaches ſwell very faſt—pinks in fine flower—a freſh quantity of moſs and common Provence roſes brought into this houſe—the firſt removed into the peach-houſe—vine-bud advances very rapidly, and is remarkably

remarkably ſtrong. Thermometer, in the night, 69 and 70 degrees; in the day, 80, 90, and 95.

March 30.—Heat begins to decreaſe—the diſuſe of the ſteam viſible in the countenances of the vegetables: cucumbers are however very prolific. Begin to ſteam again this night, leaving open all the apertures. On one plant count ten cucumbers ſwelling off. Plants in the frames very healthy; but cannot find any plant with more on it than four or five.

April 6.—Heat in the bark again begins to increaſe—poured cold water on it, between the pots of pines, and find it has a very good effect.

Cut, ſince March 30th, one hundred cucumbers, moſt of them very fine ones—the plants very healthy—leaves larger than common—French beans, peach, vine, and flowers, do equally well. The cuttings of jaſmine, geraniums, &c. ſtrike with wonderful facility.

April 10.—Nothing can exceed the fecundity of the cucumbers, the rapidity of the growth of the vine, and ſwelling of the peaches.—Their health and perfect cleanlineſs from inſects are admired by every one—indeed they exceed my moſt ſanguine expectations. Nothing fails but the addition of potatoes, as was before mentioned, for which the air requiſite for the other things is not proper; for they are drawn up very weak. Notwithſtanding, I have found ſome potatoes in each pot; but they are not in their degree of heat.

April 20.—I ſtill find that the ſource of the ſteam being under the pit, is a great evil, as I am obliged to uſe it leſs copiouſly than moſt of the things which the houſe contains require. The pines being plunged into the bed when the body of the bark is ſufficiently heated, I am obliged to do

do without ſteam, as I cannot procure it, without adding heat to the bark.

To prevent this inconvenience, ſee the* remarks made by Mr. Wakefield, in his ſubſequent letter, dated Oct. 6, 1800.

For want of ſteam, the aphis and thrips are making their appearance, neither of which, I firmly believe, would ever have been here had the ſteam been continued. However, as the pines are now the prime object, ſince cucumbers, French beans, &c. may be obtained by any mode of forcing, I attend ſolely to the quantity of ſteam the pine requires, or to what the bark requires to keep it in a proper degree of heat. Peaches ſwelled very fine, and are likely to be ſoon ripe.—Removed them into the peach-houſe.

May 15.—I find that ſteaming once in three or four days, having watch-ſticks in the bark to aſcertain the degree of heat by, is ſufficient. I have about three feet of old bark on the perforated arch, which is as firm as treading and five months ſettling can render it. If it was quite cold, I think it would require two days to bring it to a growing heat. After that, it will, as before ſaid, require the ſteam and dry flue once in three or four, or perhaps not more than once in ſix days, to be uſed.—The quantity to be aſcertained by the degree of heat required.

June, 1793.—Pines continue to do pretty well; but I think if they were by themſelves, and there were no cucumbers, &c. in the houſe, they might be managed better. As ſoon as the ſteam is diſuſed, the thrips and aphis inſects appear, but quickly diſappear on applying it again.

July.—Pines ſtill grow very fine—cucumbers do not ſo well, as I cannot ſteam for fear of hurting

hurting the pines, except when I am in want of heat in the bark, which may at any time be obtained in ſufficient quantity when the ſteam is uſed.

Auguſt.—Having determined to uſe the ſteam-houſe only for forcing cucumbers, French beans, melons, &c. and not pines, I removed the young plants into their fruiting-pots, and placed them in common ſtoves.

Sept. 2.—Having removed the young pines, the ſteam is now conſtantly employed.—Brought ſome young cucumber plants from a dung-bed, and tranſplanted them into boxes placed over the back of the pit within two feet of the glaſs; ſtill preſerving thoſe on the ſhelf at the back, though apparently going off.

Sept. 8. — Brought forty pines in fruit, and plunged them half way to the rim in the old bark, theſe being the ſame as were placed in the houſe in February.—Found it growing very hot by conſtantly uſing the ſteam.—The old cucumbers, at the bark, begin to aſſume a new appearance, and put forth fine runners. Took two of the boxes from the ſhelf, and placed them on the bark lengthways of the pit.

Sept. 10.—The young plants ſown Auguſt 21, are aſtoniſhingly fine; the old ones ſet on the bark are likewiſe very fine: but thoſe on the bark-ſhelf appear not ſo likely to produce a laſting crop as young ones. I removed them, and placed ſome young ones in their room.—Found much leſs ſteam required than in the ſpring; and that twelve gallons were ſufficient for two, and, if moiſt or rainy weather, for three nights.

Sept. 15.—Cucumbers continue to grow very rapidly — pines ſwell very well — and this day brought in ſome French beans.

Sept.

Sept. 20.—Cucumbers grew very rapidly, as alſo French beans — pines ſwell very well — potatoes were planted this day in boxes five inches deep, and two feet wide, having previouſly ſprit.

Sept. 25.—Every appearance indicates a very ſucceſsful experiment of winter-forcing. Cucumbers ſhow abundance of fruit. French beans and pines look very well.

Oct. 1, 1793.—Cucumbers look very ſtrong, and are ſhowing abundance of fruit. The leaves are remarkably large, and of a very deep black colour.—Found I had committed an error in ſtopping the apertures between the laps of glaſs with putty, as the ſteam does not paſs off ſufficiently quick.

Oct. 4.—Several fine fruit ſhows on the cucumbers, which look remarkably fine. Pines ſwell very faſt, there being an amazing heat in the bark. Water evaporated, only ſix gallons laſt night.—Thermometer, 67 at night, and 80 degrees in the day; when plunged in the bark, 105 degrees.

Oct. 10.—Cucumbers continue very fine, and as luxuriant as ever I ſaw them; but do not ſhow ſo much fruit as in the ſpring—ſome few are ſwelling, and one is in great forwardneſs. Pines ſwell their fruit very faſt. French beans are finer than I ever ſaw at this ſeaſon of the year.

Oct. 22.—Cut a fine cucumber this day, being ſeven weeks and three days from the time of ſowing ſeed; a great number ſwelling off. Pines and French beans ſtill do well. Water evaporated, from ſix to ten gallons per night, according to the weather.

Nov. 1.—Cut ſome fine fruit this day from the cucumbers, and ſome pines that have a very good appearance.

Took the vine out of the pot, and placed it in a pit that had no fire, to harden the wood, having made a ſhoot from a very ſmall plant, as before mentioned, of forty-two feet in length, thirty of which is fine firm ripe wood, with very round prominent eyes—not the leaſt appearance of a root coming through the holes of the pot.

Nov. 10. I was very much diſappointed this morning in finding that the flue under the arch had burſt, and that there had been much ſmoke and ſulphur in the houſe all night. The deſtruction this had occaſioned among the plants in the houſe was great. The French beans, and all the young fruit and tender branches of the plants, were totally deſtroyed. This misfortune happened through the negligence of a bricklayer in not cleanſing the flues.

Nov. 20.—After the misfortune that happened on the 10th inſtant, I conceived that nothing more was to be expected from the cucumbers. I immediately had the flues cleaned; and having continued the ſteam ever ſince, I found that they were breaking out freſh and ſtrong, and ſhowing abundance of fruit. Had the plants received ſuch a ſhock in a frame, I am certain that they could not have been ſo quickly brought about by any method, and I much doubt whether it would have been poſſible to effect it at all.

Nov. 25.—The cucumbers are doing well, beyond any conception I had formed, after experiencing the laſt misfortune. French beans are tolerably good; but I find that want of light is

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the only miſchief which we have naturally to encounter.

Sowed ſome cucumber-ſeed in a pan, and placed in the ſteam-houſe.

Dec. 1.—Cucumber plants ſown the firſt are up, and look very well—the old ones ſhow abundance of fruit, but do not ſwell them off freely.

At the time of erecting this houſe, I conceived that it was neceſſary to have it as air-tight as poſſible; and therefore I ſtopped every crevice, and laid putty between every ſquare at the lap. I think it would have been better, had they been left open, and am now taking away the putty.

Dec. 24.—Since the firſt inſtant I have experienced, that to ſtop the apertures between the ſquares with putty is an error; for, ſince I have removed it, the plants which before were always too wet, are now eaſily dried by uſing the dry flue, even in dark wet weather. The fruit on theſe plants ſwells more freely, and the young plants look very well.

Brought in this day ſome hyacinths, roſes, carnation, pink, and ſyringa roots. The weather being dark, uſed but little water, ten gallons per evening being the mean quantity. If windy, more, if rainy, leſs is required. The plants ſhould juſt be tipped on the edges in a morning, ſimilar to the vegetables in a ſummer morning which has been preceded by a ſhowery day. No certain rule can be laid down how a knowledge may be obtained of the quantity of water requiſite to gain this deſirable criterion of good management. An attentive obſerver will ſoon be able, by the appearance of the atmoſphere, to judge the quantity requiſite, both of heat and

moiſture.

moiſture.—And here I would wiſh to give it as my opinion, that nature does not act by rules in rearing her tender ſaplings, but often changes her mode of treatment, from one extreme to another, in the ſpace of twenty-four hours; I do not mean to ſay, that plants raiſed by art are as capable of ſuſtaining ſuch rude ſhocks as thoſe left to nature; but this I believe, that more are killed by kindneſs than by bold management, both in the animal and vegetable world; from whence I infer, that a few degrees of difference in heat, or a few gallons of water, will not be productive of any bad conſequence.

Nov. 29.—Stormy day—admitted a little air by propping up the bottom lights with a ſtone. The weather being windy, kept the holes open for the ſteam the greater part of the day. Cucumbers look very well—pines ſwell very faſt. My foreman ſays that the Black Jamaica has ſwelled half a pound ſince it was firſt brought here.

Water uſed laſt night and to-day, ten gallons. Thermometer, 68 degrees at night—plunged into the bark, 101 degrees.

Dec. 6.—The ſeaſon is at preſent as unfavourable for forcing as poſſible; and the ſteam has not been uſed ſo much as if the weather had been dry and windy. Every thing looks tolerably well, and ſome cucumbers ſwell as freely as any I ever ſaw. French beans grow better than I ever ſaw at this ſeaſon; and a few pines ſwell very well. However, I have no doubt, if the weather was not quite ſo wet, and I could uſe the ſteam more copiouſly, but that I ſhould be better ſatisfied.

1795. Jan. 6.—Cut this day, from the ſteam-houſe, ſeven as fine cucumbers as I ever ſaw in the month of May. The weather being froſty

and clear, the ſteam is now uſed to great advantage. Fruit, that during the dark weather looked bright and well, but remained ſuſpended as ſoon as the atmoſphere became clear, and the ſun burſt forth, ſwelled away with a rapidity ſcarcely to be credited. The French beans are growing equally well. Pines ſwell very faſt, and the cuttings of the Hydragonum Hortenſium, and Roſea ſemper flora, ſtrike with great facility.

Thermometer, ſuſpended in the houſe, 68 degrees in the night—plunged into the bark, 100 degrees Nairne. In the open air, 26 degrees 6 minutes below frezing.

Jan. 13.—Cut nine fine cucumbers, and gathered a quantity of fine French beans. The weather ſtill froſty, and conſequently clear. Pines ſwell very faſt. Thermometer, ſuſpended in the houſe, 70 degrees, Fahrenheit's ſcale; 100, plunged into the old bark; 20 in the open air; and 12 below the freezing point.

Water evaporated, about twenty gallons per night, much more being requiſite in froſty than in mild weather. Quanty of coals burned, during the laſt twenty-four hours, three baſkets, which are nearly equal to four buſhels.

Jan. 20.—Cut this day thirteen cucumbers, and gathered a fine diſh of French beans. Every thing is in as flouriſhing a condition as it is poſſible to conceive. Pines ſwell very faſt. Thermometer remained, during the night, at 61 degrees. Sharp froſt.—Thermometer, in the open air, 19 degrees 18 minutes, being 13 or 14 degrees below freezing.

Water evaporated, twenty gallons during the night, viz. from three o'clock P. M. until ſeven o'clock A. M.

Jan.

Jan. 22.—Though the thermometer has been in the open air the laſt night, at 16 degrees, being 16 degrees below the freezing point, yet the plants in this houſe look as well as ever, the cucumbers having ſwelled their fruit as freely, or more ſo, than when the thermometer ſtood at 36 or 40 degrees.

Jan. 24.—Though yeſterday and this day have been cloudy, and attended with ſome ſnow, (the thermometer in the open air being at 25 degrees Fahrenheit) yet every thing flouriſhes admirably. The cucumbers are as fine as they can be conceived to be, growing very ſtrait and rapidly. Three days ſince, I cut all that I could obtain; yet I meaſured one this day, and found it to be nine inches, which, on Tueſday the 20th inſtant, was only ſix inches in length. There is a beautiful bloom on it, and ſuch as appears on thoſe growing in dung in April, when the bed is in a fine growing ſtate.

The young plants exceed thoſe in the frames in the ratio of two to one. Some French beans planted in the common ſtove, at the ſame time as the plants were in this department, are not to be compared with them, as the plants are now in fruit, while the French beans, though they look very well, are not in bloom: the roſes are blooming very finely.

Water evaporated laſt night, fourteen gallons. Thermometer, 70 degrees.

Jan. 26.—Cut this day ſeven brace of cucumbers, as fine as any I ever ſaw cut in April from dung-beds. I likewiſe cut ſome French beans. Pines ſwell very well; one that ſhowed its fruit in 1794, and was then brought into this department, is now changing colour. The one that ſhowed fruit

fruit in November, is ſwelled very faſt. Thermometer, 70 degrees; in the open air, 44 degrees thawing.

Water uſed, twenty gallons in twenty four hours.

Jan. 30.—The froſt which is again ſet in, was laſt night remarkably ſevere; the thermometer being at 15½ degrees. Yet nothing can exceed the beauty and healthful appearance of every thing in this houſe. It has been the opinion of ſome experienced in horticulture, that it would be impoſſible to do any good with ſteam in very ſevere froſt; but I always entertained a different opinion, and am highly gratified to find that I was not miſtaken. It is now nearly two years ſince I firſt began to try experiments with ſteam; and one circumſtance only excepted, viz. the accident of the flue's burſting, in November, 1793, I have uniformly found every thing in this department always clean, healthy, and vigorous, beyond any inſtance I have ever witneſſed; and I have no doubt, ſhould I live two years longer, of being ſtill a witneſs of its wonderful efficacy in aſſiſting vegetation, and of being enabled, during the ſpring and ſummer months, to bring every ſpecies of fruit to perfection, without the danger of being diſappointed through inſects, the natural conſequence of a dry heat.

Feb. 3.—Laid a foot thick of rich ſoil on one half of the pit in this department, in order to turn ſome pine plants that are juſt ſhowing their fruit into it, out of their pots.

Cut this day ſeven brace of very fine cucumbers, a quantity of fine French beans, and a very fine pine, which has never been in any place ſince it

was in bloom but this houſe; and no bark has been brought in here ſince February, 1793.

Young cucumber-plants ſown in December, 1794, are growing very faſt, though the weather is very much againſt forcing. Laſt night there was a heavy fall of ſnow. Thermometer, in the open air, 24; in the ſteam-houſe 70 degrees.

Feb. 9.—Cut this day thirteen cucumbers, and a great quantity of French beans from the ſteam-houſe; every thing being in a flouriſhing ſtate. The earth that was brought into this department on the 3d inſtant, and laid on the bark, fourteen inches thick, and only half the breadth of the pit, is this day of a fine temperate warmth. Water evaporated, twenty-ſix gallons laſt night, being windy. Thermometer, in the open air, 38 degrees.

Feb. 10.—Turned ſixty-ſix pine-plants out of their pots, and planted them in the ſoil over the ſteam without any bark, the ſoil being of a fine temperate heat.

Feb. 16.—Cut this day five brace of cucumbers off the plants in this houſe.

Pines that were turned out of the pots look extremely well, as alſo does every thing in this houſe. Water uſed, twenty-four gallons during the night.

Feb. 23.—Cut this day ſix and a half brace of cucumbers, and a great quantity of French beans. Cucumbers are amazingly vigorous. Pine plants that were turned out of the pots look extremely well. Water as before.

March 2.—Notwithſtanding the weather is very unfavourable to forcing, every thing looks well in this department. Cut this day ſix brace of cucumbers, and plenty of French beans. The

pines look extremely well, and I have this day brought in the miraculous vine, to fee if it will effect any thing this feafon. Turned fome plants of cucumbers out of fmall pots into tubs, there being one fruit on one of the pots. Water evaporated, twenty to twenty-four gallons. Thermometer, 73 in the night, and 80 degrees in the day; when fufpended in the open air, 30 to 33 degrees.

March 9.—The weather is ftill as unfavourable as I ever knew it to be, fo that it is with great difficulty that I can look into a frame; which makes a fteam-houfe a very defirable thing, as, through this, neceffary attendance may be paid to thofe vegetables that require it in any weather. Cucumbers are ftill fine. Cut this day the ufual quantity. The pines growing without pots or bark look extremely well.

March 16, 1794.—I never remember fuch a feafon as this. So much fnow, and fo little fun, in March, are very uncommon. In fome places the fnow is two feet in thicknefs. I think I could not have had a more unfavourable feafon for experiments. However the different kinds of plants in this houfe look very well. Cut this day thirteen cucumbers, and a great quantity of French beans. The pines have a good appearance, and the vine is breaking that bore the miraculous crop laft year, and in the fame pot, in a manner that is truly aftonifhing.

Water ufed, twenty gallons in the night. Thermometer 65 degrees in the night, and 70 degrees in the day; in the open air, 28 to 36 degrees.

Defcription

Description of the Steam House invented by Mr. WAKEFIELD.

Fig. 1. (Pl. XIII.) The ground-plan, ſhowing the direction of the flues, upon two of which, A B, are placed flat copper pans, extending from C to D, three inches in depth, and made of thin rolled copper. Theſe pans are fixed in the brick-work, and ſupported by flat iron bars underneath; are incloſed in the ſteam vaults E, repreſented in the ſection of the houſe, Fig. 2. and ſteam is formed from water poured within them.

The roof of the vault F is a perforated brick arch, (See Fig. 5.) admitting the ſteam through the tan or ſoil G G, which is placed upon the arch after it is covered with ſmall ſlates or tiles, to prevent the tan or ſoil in which the plants grow or are plunged, from trickling through the ſaid arch.

The width of the ſoil-bed or pit is ſix feet; the depth of the ſteam-vault E, is four feet from the bottom of the flue to the centre of the arch; and the inſide width of each of theſe flues A B, is fifteen inches. The height, from their bottom to the underſide of the copper pans, is twenty inches. Each of theſe flues has a furnace H H, at the oppoſite ends of the houſe, aud the ſmoke paſſes on through the back flues I.

There muſt be a ſeparate furnace K, for the front flue L M, which flue is within the ſteam-houſe, and more elevated than the arch F. Upon this flue is placed a flat copper pan, ſimilar to thoſe already deſcribed; this pan extending from L to M, is uſed occaſionally with or with-

 out

out water therein, as may be found ſuitable to the purpoſes explained in Mr. Wakefield's ſubſequent letter.

At N is a leaden pipe to convey the water into the back pans below the arch: the other pans below are ſupplied in a ſimilar manner. At O there are ſquare holes, which muſt be left the whole length of the building, to allow ſteam to mix plentifully with the atmoſphere in the houſe.

Fig. 2. is a ſection of the ſteam-houſe: for references to the letters, ſee the accounts above.

Fig. 3. ſhows the form of one of the copper pans, upon a larger ſcale. P is the bottom of the pan; Q, the edges placed within the brick-work.

Fig. 4. is a ſection of the pan and flue, to ſhow the manner it is fixed in the brick-work, and the depth of the flue.

Fig. 5. is an upper view of the arch, to ſhow the perforations therein previous to their being covered with tiles.

Mr. Wakefield adds, that it is better to have a long copper pan upon each flue, than ſeveral ſmall ones. Mr. Butler's pan was made of iron: but copper pans are ſuperior for the purpoſe.

The Duke of Bridgewater has lately built a ſteam-houſe on the preſent plan, which anſwers his expectations. I cannot ſay whether Lord Derby's ſteam-houſe is now uſed or not, as Mr. Butler has left Knowſley, and I have not been there ſince.

It muſt be obſerved, in Mr. Butler's experiments, that the bark was ſometimes ſo heated by the

Fig 4.

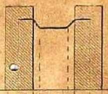


Fig 3.

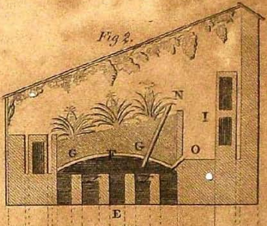


Fig 2.

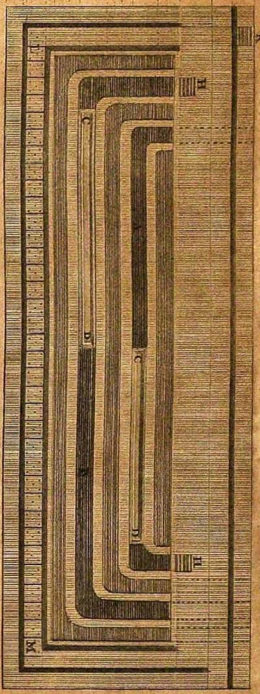


Fig 1.

Fig 5.

the ſteam below, as to render the continuance of it in that direction improper; therefore a copper ſteam-pan has ſince been placed over the front flue of the ſtove, and extending the whole length of the front, from L to M. Fig. 1. This copper pan is covered with perforated tiles, ſimilar to thoſe uſed in drying malt, which afford the opportunity of pots of French beans being placed thereon. This ſituation is peculiarly favourable to theſe plants; and, at the ſame time, permits a ſufficient quantity of ſteam for other plants in the houſe to aſcend through the tiles, from the water heated in the copper pan beneath them.

Where there is no front flue in a vine-houſe, it will be found very ſerviceable to fix a flat iron boiler at the back of the vine-houſe, in ſuch a manner that the ſteam may paſs from it by pipes through the wall from an arch or cover made over the boiler.

It is neceſſary, in the conſtruction of all ſteam-houſes, to be particularly careful that the flues for the ſmoke be ſound and perfect, as nothing is more injurious to vegetation than ſmoke pervading the houſe from holes or fiſſures in the flues.

XL. *Description of a Method of turning Spherical Forms in Wood, in a more expeditious Manner than usually practised. By Mr.* THOMAS COOK, *of Newington, Surrey.*

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

A Bounty of Twenty Guineas was voted to Mr. COOK for this Invention.

THE following is a description of the method of preparing and turning a true round or spherical figure, between two centres, principally upon a large scale, by means of the large wheel commonly made use of by turners.

Prepare, of wood, as near a cube as may be; plane one side true, and gauge a line down the middle, from which line the centres are at each end found with a pair of compasses. Then form the piece to an octagon, by taking off the four corners: place it in the lathe, and lay the band on, about one third from the end; then strike each end to the exact length of the intended diameter. With a pair of compasses, divide the piece which gives the centre or curve line, and bisects the gauge stroke; strike it with a chissel, then with a small gouge, which makes a groove for the band to work, in taking care not to diminish the size of the diameter. From the middle work down each end with a gouge, to as fair a round as you can by eye, or with the callipers: then take the piece out,

out, and carefully prick the second centres, which the gauge stroke and curve line give. Place in the lathe the last pricked centres, and pass the piece round by hand. Work down with a small firming chissel, in order to form a second curve line, until it bisects the first diameter or curve line: then strike the piece to the first centres, and work off the remaining wood with a large firming chissel, until it becomes flush with the second curve line: it may then be polished. Throw off the band, and turn round the ball by hand, to work off the groove the band played in. Should you not think fit to pass the ball by hand, shift your rest to the opposite side, and have the wheel turn the reverse way; by this means you turn off the groove. To polish the remainder, the band will play on the surface of the ball, by being steadied with the hand.

XLI. *Account of the Processes employed in the Manufacture of Brass Plates at Stollberg.*

FROM THE *JOURNAL DES ARTS ET MANUFACTURES.*

THE Commune of Stollberg, in the district of Juliers, situated about two leagues from Aix la Chapelle, is eminent for the manufacture of brass plates. The commerce which is carried on in this article is enormous; thirty-eight manufactories are kept constantly at work, in order to supply the demands.

The

The manufacturers obtain from foreign parts immense quantities of molten copper, in order to fabricate it into brass; as from Drontheim in Norway, from Hungary, from Sweden, from several provinces of Germany, and from Cornwall in England. That which is procured from the last-mentioned province, and that from Norway, are the best in quality.

The calamine which is used is principally obtained from Vielle Montagne, near Aix la Chapelle, and from the territory of Cornely Munster, near Stollberg. It is on account of the facility with which this mineral is here obtained that the manufactories of brass have been established at Stollberg.

As to the mode in which this manufacture is carried on; crucibles are employed, made of an argillaceous earth, mixed with fragments of crucibles no more fit for use, which are pulverised, and blended with the above-mentioned earth, in the proportion of one quarter of the whole. The argill is obtained from the neighbourhood of Namur: it is of a fine texture, of a bluish colour, and easy to be moulded. The crucibles are made about fifteen inches in height, an inch and a half in thickness, with an aperture of about eight or nine inches, and a depth of twelve or thirteen. Into these crucibles the substances intended to be manufactured into brass are introduced.

The furnaces in which the copper is to be fused are placed on the ground; their outlet is upon a level with the floor of the work-shop; and a deep trough is made on the flat pavement, to serve as a gallery, to support the fire, and to admit a current of air to the ash-pit.

The form of these furnaces is that of a cylinder, terminated by a narrow neck; they are forty inches in height, twenty-eight in width, and at the aperture, or summit, fourteen or fifteen.

During the operation, they are covered with a plate of earth of the same materials with the crucibles: their interior part is brick-work of the same kind of earth, mixed with fragments of crucibles reduced to a coarse powder.

When the furnaces are to be charged, the copper-plates are first broken into as small pieces as possible. Into each crucible is then introduced a mixture of the following materials, viz. forty pounds of copper, sixty-five pounds of calamine well pulverised, and double its volume of charcoal, likewise pulverised. With this mixture the crucibles are filled, and placed in two tiers, the one above the other; eight crucibles to each furnace.

The calamine and charcoal are pulverised by means of an ordinary water-mill. The stones employed are of the basaltes of Andernach.

The crucibles being arranged as above described, a vehement fire of pit-coal is kept up for the space of twelve hours. The fuel is placed upon an iron grate, at the distance of only twenty, or twenty-two inches, from that which separates the crucibles.

After the fire has been kept up for twelve hours, a workman lays hold of each crucible with a pair of iron tongs, and throws it forcibly upon a bed of sand, in order to form a hole, into which the matter is made to run. The same workman previously separates, with an iron trowel, all the scum and charcoal which swim upon the liquid, and deposit themselves at the upper part of the

crucible.

crucible. This fubftance, when cooled, forms a a mafs, which is termed *arkoft*.

This is only the firft part of the operation, and its product is brafs, of a coarfe, brittle, and unequal texture, which muft be fubjected to a fecond fufion in order to be rendered perfect. For this purpofe the fame crucibles are again employed. Firft, are thrown into each three handfulls of the mixture of charcoal and calamine, according to the proportions above-mentioned. Over thefe are placed two or three pounds of brafs clippings; then two more handfulls of the firft mixture are introduced, together with a piece of *arkoft* about a pound in weight, and thefe are finally covered with the firft-mentioned powder.

The crucibles being charged in this manner, they are placed in the furnaces, from which they are withdrawn after a fpace of two hours, in order to caft the new liquid into plates.

Thefe plates are manufactured with the aid of two blocks of very hard granite, five feet long, three and a half broad, and eight inches thick. Thefe are placed one above the other: the upper block is raifed by means of a pulley, in order to be wafhed and rubbed with cow-dung. It is prepared in this manner before the cafting of the metal.

In order to give the plate the degree of thicknefs which is defired, hoops of iron of different dimenfions are adapted to the inferior ftone, which ferve to confine the fufed metal and determine its thicknefs. The firft ftone is then replaced, and both receive the degree of inclination requifite for facilitating the entrance of the liquid. In fact, they perform the office of a mould.

The

The plates which are made in this manner vary in length, breadth, and thicknefs, from the fixth of a line to eight lines.

If we examine the arkoft in its fracture, with the help of a magnifying glafs, we perceive the calamine intermingled with the copper in the fame manner as charcoal with fteel; and it appears that thefe two fubftances are not yet combined, but only mixed with each other. The carbon which is employed in this operation attracts the oxygene of the calamine, which is thus reduced to zinc. In this ftate its combination with copper is more eafy, whereby brafs is formed.

Thefe plates are applied to a variety of purpofes at Stollberg: amongft others, they are manufactured into wire of various dimenfions.

To prepare them for this operation, they are cut into ftripes of different breadths with a large pair of fhears; after which they are fixed to drawing-irons, which are worked by means of a water-mill.

The manufacture of pins is principally carried on at Stollberg by the labour of children.

The plates are exported to France, Holland, Portugal, and Switzerland, where they are ufed in the manufacture of clocks and watches; alfo to Germany, Spain, and Italy.

The fubftance employed in manufacturing brafs is, as I have already obferved, compofed of forty pounds of copper, fixty of calcined calamine, and twice its volume of pulverifed charcoal. From this mixture are produced 53, 54, and fometimes 55 pounds of brafs.

The calamine, as ufed at Stollberg, did not appear to me to be fufficiently pulverifed. They

 do

do not employ the bolting-cloth, which is ſo uſeful where a very fine powder is required.

The blocks of granite, which are uſed in caſting the braſs plates, are obtained from St. Malo. This granite is compoſed of grey quartz, ſchorl, and mica intermingled in pretty uniform proportions, and forming a compound of very great hardneſs.

Before pouring out the melted metal, they uſe the precaution to heat the blocks.

I ſhall not enlarge upon the mode in which the caſt plates are manufactured into wrought plates. The operation conſiſts in placing the plates of copper under the hammer, by which they are beat into the requiſite extent and thickneſs.

XLII. *Of the Manufacture of Soap.*

FROM THE *JOURNAL DES ARTS ET MANUFACTURES.*

GREAT quantities of ſoap are daily conſumed both for the common purpoſes of life, and in different manufactures. A great ſcarcity of this article was experienced towards the end of the year 1793, when the civil commotions by which France was agitated had forced a great number of the manufacturers of Marſeilles to relinquiſh their occupations, which had been uſed to furniſh the beſt ſoap known in commerce, and to ſupply with it not only France but alſo foreign countries.

At this period new manufactories of ſoap were eſtabliſhed in different parts of the republic; but, whether

is a combination of ſoda with muriatic acid. Proceſſes have been invented, and practiſed in the large way, for ſeparating theſe two principles, and obtaining the ſoda free from combination. The chemiſts mentioned in the beginning of this paper have publiſhed a very intereſting account of the proceſſes at preſent known for decompoſing ſea-ſalt.

All the varieties of alkalies which we have hitherto mentioned do not proceed from any variation in the conſtituent principles of the ſoda, or pot-aſh; for theſe two ſubſtances have as yet reſiſted all the endeavours of the chemiſts to decompoſe them, and appear to be unalterable: their varieties are owing to an admixture or combination of various foreign ſubſtances, the abſence or preſence of which conſtitutes what is called the good or bad quality of the pot-aſh or ſoda.

If the foreign ſubſtances mixed with the alkalies be inſoluble in water, we may lixiviate the whole, in which caſe the water will carry off the alkali which it diſſolves, after which we have nothing more to do, in order to obtain the alkali in a concrete form, than to condenſe the lixivium, and evaporate it to dryneſs.

If the foreign ſubſtances be of a ſaline nature, and ſoluble in water, they will then follow the alkali in the lixivium; but there are various means by which their ſeparation may be effected.

The ſoda, even when diſengaged from the earthy and ſaline particles of which we have been ſpeaking, is in its moſt ordinary ſtate almoſt entirely ſaturated with *carbonic acid**: its tendency

* Pot-aſh, in its ordinary ſtate, contains alſo a certain quantity of carbonic acid, but in a ſmaller proportion than ſoda.

to

to combination being thus satisfied, it exerts scarcely any action on the animal substances and oils, with which it readily combines when in its pure state. It is therefore necessary that we should know how to deprive the alkalies of the carbonic acid combined with them.

For this purpose we employ *lime*, which exerting upon the carbonic acid an affinity stronger than that of the pot-ash and the soda, disengages that acid from them and leaves them pure. The alkalies, when thus reduced to their pure state, and possessing their whole tendency to combination, were formerly termed *caustic alkalies.* The ancient chemists imagined that the lime furnished some principle which augmented the intensity of their qualities; but it has been since satisfactorily demonstrated, that it does nothing more than disengage from them a foreign substance which impeded their action. Thus lime is, in fact, an indispensable requisite in the manufacture of soap; but we are not to imagine that it becomes a constituent part of the soap; its real function is to purify the alkalies and dispose them to combine with the oil. We shall only observe, that lime loses a part of its powers by remaining exposed to the atmosphere, and that if we wish to preserve them, we must keep it in close vessels.

To return to our subject: let us suppose that we wish to clear a piece of cloth from the oil or fat with which it is impregnated. The most simple method that occurs to us will be to combine this oil or fat with an alkali; the compound, being now soluble in water, may be extracted by washing. The ashes which are added to the lye used in bleaching linen are intended for no other purpose, which is effected by the water seizing upon the

the alkali which it finds in the ashes, and carrying it through the linen. In passing through the linen, the alkali combines with any oily substance which it meets. In this state of combination, these substances, being susceptible of being dissolved in, and mixed with, the water which continues to be supplied, are carried out of the vessel in which the operation is performed. The immediate application of pure alkali, however, is attended with various inconveniences.

It is difficult, especially for that class of people who are generally employed for scouring clothes, to hit upon the exact proportion of alkali that should be used. If the due proportion be exceeded, the cloth, of whatever kind it may be, which they are employed to clean, will be attacked and injured by the alkali; and even where the proportion has been observed with the greatest accuracy, the alkalies have still the disadvantage that they destroy the colours, corrode animal substances, such as wool or silk, and give to linen a red colour, and render it stiff.

Soap, which, as we have already seen, is a combination of an alkali with some fatty or oily matter, is exempt from the inconveniences which attend the immediate application of alkali, and answers the purposed end as well as the latter; like alkali, it forms with oils or fats combinations miscible with water; but its effect on the colours is scarcely perceptible; it gives to linen whiteness and softness, neither does it injure the quality of the cloth, even though it be made of animal substances, such as wool and silk.

In soap, therefore, we find united all the qualities that can be desired for cleansing vegetable and animal substances from oil or fat.

 There

There are two ſpecies of ſoap: the *ſolid*, which is employed for the common domeſtic uſes, and the *ſoft* ſoaps, of the conſiſtence of a paſte, great quantities of which are conſumed by the fullers in cleaning woollen, ſtuffs, &c.

The firſt ſpecies is obtained by uſing ſoda for the compoſition; pot-aſh can furniſh no other than ſoft ſoap. Even tallow, which naturally aſſumes the ſolid form, yields, when combined with pot-aſh a ſoft greaſy ſoap.

Some have aſſerted that it is poſſible to obtain a ſolid ſoap with pot-aſh, by means of an addition of *muriate of ſoda*, or ſea-ſalt. The Citizens Darcel, Pelletier, and Lelièvre, made the following experiment in order to aſcertain the fact. They converted three pounds of olive oil into ſoap by means of pot-aſh. The product was ſix pounds of a ſoft greaſy ſoap, which was not firmer in its conſiſtence than fat. They then diſſolved ſix pounds of muriate of ſoda in a ſufficient quantity of water, a part of which ſolution they mixed with the ſoap, and boiled the whole, taking care to ſtir it inceſſantly. Thus they continued to proceed till they had added by degrees the whole of the ſolution. After it had boiled for two hours they removed the veſſel from the fire and ſet it by to cool. In this manner they obtained a very ſolid ſoap. The bottom of the veſſel was occupied by a conſiderable quantity of a ſalt which had depoſited itſelf there for want of water to hold it in ſolution. They then ſeparated the ſoap from the ſalt, and having liquified it with a ſmall quantity of water, poured it into a proper veſſel. The ſoap obtained by this proceſs was ſolid, white, of an agreeable ſmell, and poſſeſſed all the qualities

lities of ſoap prepared with the ſame oil and ſoda.

In order to explain the phenomena which took place in this experiment, we muſt remember that the muriate of ſoda is compoſed of two conſtituent principles; namely, *muriatic acid* and *ſoda*. We muſt alſo know, that pot-aſh tends to combine with muriatic acid by a ſtronger affinity than that which ſoda poſſeſſes for the ſame acid. This being the caſe, when we have added muriate of ſoda to ſoap with a baſe of pot-aſh, the muriatic acid has abandoned the ſoda in order to combine with the pot-aſh, which, on the other hand, is diſengaged from the oil with which it had been combined in the ſtate of ſoap. This firſt combination has produced *muriate of pot-aſh*. The ſoda, diſengaged from the muriatic acid, has combined with the oil. This ſecond combination has produced ſoap with a baſe of ſoda; it is therefore natural that this ſoap ſhould exhibit all the characters which belong to that obtained by the direct combination of ſoda with oil.

If it were poſſible ſtill to have any doubts of the juſtneſs of the explanation we have given, they muſt vaniſh on conſidering the following fact.

In an experiment, in every reſpect ſimilar to that which we have related, inſtead of *muriate of ſoda*, *ſulphate of ſoda* * was employed, and the ſoap with a baſe of pot-aſh acquired the ſame ſolidity as in the former inſtance. In this experiment the ſame play of affinities took place as in the former, ſubſtituting the ſulphuric acid in the place of the muriatic.

* *Glauber's ſalt*, according to the old nomenclature.

Thus the experiment, which at first sight might seem to overthrow the position which we have advanced concerning the consistence of soap with a base of pot-ash, only tends to confirm it.

Soap of a very solid consistence has been obtained by commencing the operation with the lye of pot-ash, and completing it with that of soda.

Practical observation had led manufacturers to imagine, that the use of sea-salt, or muriate of soda, was indispensably necessary if they wished to obtain solid soap, even though soda had been used for converting the oil into soap. Citizens Darcel, Pelletier, and Lelièvre, have demonstrated, by repeated experiments, that the addition of this salt is only a matter of convenience, not of necessity; for they have obtained very solid and good soap without employing it. However, as we shall see hereafter, muriate of soda is used in large manufactories: its effect is to accelerate the separation of the soap from the aqueous liquid which has been employed in boiling it. The manner in which it acts is as follows: the water tends to combine with the muriate of soda by a stronger affinity than that which unites it with the soap; consequently it abandons the latter in order to seize upon and dissolve the muriate of soda; the soap which it before held in a state of liquefaction, being now separated from it, presents itself in the form of a granulated paste. The use of the muriate of soda, or sea-salt, in the manufacture of soap, has no other object than that which we have just explained.

All oils are not equally adapted for the manufacture of solid soap. The experiments of Citizens Darcel, Pelletier, and Lelièvre, enabled them to class the oils pretty nearly in the following order,

order, according to their different degrees of aptitude for forming good ſoap, placing thoſe which poſſeſs this quality in the higheſt degree in the firſt rank. 1. Oil of olives, oil of ſweet almonds; 2. Animal oils, ſuch as ſoap, fat, butter, &c. 3. Oil of *Colza*, oil of turnips; 4. Oil of beech-maſh; 5. Fiſh-oil *; 6. Oil of hempſeed; 7. Nut-oil, lintſeed-oil.

In the third ſection ſhall be found further details concerning the properties of the ſolid ſoaps, which reſult from the employment of the different ſpecies of oils.

The oils of hempſeed, colza, turnip, and lintſeed, are moſt generally uſed in the manufactories of ſoap in the form of paſte. The Dutch uſe alſo the fiſh-oils; but the ſoaps manufactured in this manner have a diſagreeable ſmell, and are inferior in quality to thoſe made in the French manufactories, where great care is taken to avoid the uſe of ſuch oils, in order that their ſoaps may preſerve their ſuperiority.

For the purpoſe of converting oil into ſoap, cauſtic alkaline lyes are prepared of different degrees of ſtrength. The weakeſt of theſe indicate from four to eight degrees of the areometer, and the ſtrongeſt from 18 to 25. A mixture is made of oil and the weakeſt lye, which is heated to the boiling point, care being taken to ſtir it conſtantly, in order to multiply the points of contact and facilitate the combination. They continue to add lye, but always proceeding from the weaker to the ſtronger, and the ſame temperature is uniformly maintained. The mixture at firſt aſſumes the appearance of milk; gradually, and in pro-

* The oils of this claſs and the preceding require to be mixed with olive oil, or the animal oils.

portion

portion as the combination proceeds, it acquires a firmer consistence, and at last it separates itself into two parts, the one of which is an aqueous liquid, and the other the saponaceous substance in the form of a granulated paste. We shall see in the second section in what manner this substance is subsequently treated, in order to reduce it to the state of soap, such as we meet with in commerce; but our present object is merely to shew, in a summary manner, how the combination of oils with alkalies is effected. We have observed that the temperature is raised to the boiling point; but this degree of heat is not of indispensable necessity, for we shall see hereafter that soap may be manufactured in the ordinary temperature of the atmosphere. We shall also examine and resolve the question, whether it be more œconomical to manufacture soap in the ordinary temperature of the atmosphere, or with an augmentation of heat.

In the second section will be explained the method of preparing the alkaline lyes of which we have spoken; at present we shall content ourselves with laying down the proportions in which the lime is to be employed, in order to obtain by the lixiviation a pure alkali, perfectly disengaged from carbonic acid, and consequently possessing its whole caustic power.

To a quantity of the soda of commerce, whose weight is expressed by 100, is required a weight of quick-lime equal to 20 or 25; the weight expressed by 20 is in general sufficient. With the lyes produced from this quantity of soda we may convert into soap a weight of olive oil expressed by 120, and the soap which is produced

produced by this proceſs is equal in weight to 200.

Recapitulation.

Soda of commerce, - -	100 by weight.
Quick-lime, - - - - - -	20
Oil, - - - - - - - - - -	120
Soap produced, - -	200

In order to render cauſtic the pot-aſh of the North, known by the name of Dantzic pot-aſh, the ſoap-manufacturers of Flanders and Picardy employ quick-lime in the proportion of 80 by weight to a weight of pot-aſh equal to 100.

Freſh manufactured ſoap always contains a conſiderable quantity of water, which muſt be allowed ſufficient time to evaporate, by keeping the ſoap expoſed to the atmoſphere in a dry place. Honeſt manufacturers, who pay a proper regard to their reputation, always wait till their ſoap has attained the proper degree of dryneſs before they expoſe it for ſale; thoſe, on the contrary, whoſe rule of conduct is avarice, and who concern themſelves little about the rectitude of the means which they employ in order to gratify that paſſion, make haſte to ſell their ſoap whilſt it is freſh, and, ſhould the courſe of commerce oblige them to keep it by them for ſome time, they make uſe of various fraudulent methods in order to prevent the evaporation of the water, or to reſtore to it that which it has loſt in this manner, and even to combine with the ſoap a larger quantity of it than it contained immediately after it had been manufactured. The following calculation will afford the reader an idea of the frauds which are practiſed in this manner.

Before

Before ſoap manufactured with olive-oil can be conſidered as proper for ſale, it ought to have loſt by evaporation a part of its weight, nearly equal to a third of that which it weighs at preſent, or a quarter of what was its weight when freſh prepared. Thus the manufacturer who vends this article immediately after it has been prepared, defrauds the conſumer to the amount of 32 or 33 *per cent.* of the market-price which ſoap bears when dried, or of 25 *per cent.* of its market-price before it has dried.

Chemical analyſis has ſhewn, that in that ſtate of dryneſs, in which it may be allowed to be ſold, without injury either to the manufacturer or the conſumer, the conſtituent principles of ſoap are contained in it in the following proportions.

Suppoſe that we have a piece of ſoap equal in weight to 1000, it will contain:

Olive oil, - - -	609
Pure alkali, - -	86
Water, - - - -	305
Total, -	1000

The compoſition of the ſame piece of ſoap, when freſh prepared, was as follows:

Olive oil, - - -	609
Pure alkali, - - -	86
Water, - - - -	637
Total, -	1332

Thus the conſumer who ſhould purchaſe it in this ſtate would have to pay the value of as much ſoap as would be equal in weight to the exceſs of water,

water, or $\frac{332}{1000}$, for what can be of no uſe to him.

The calculation which we have here given applies only to ſoap made of olive-oil; the reſults being very different according to the nature of the different oils. We ſhall treat more largely hereafter of this ſubject, as well as of other frauds which are practiſed by the dealers on the conſumers. But it is time that we ſhould proceed to the conſideration of the practical operations belonging to the manufacture of ſoap, which we ſhall make the ſubject of next ſection.

SECT. II.

Operations of the Manufacture of Soap.

Manufactures naturally eſtabliſh themſelves in places where they meet with circumſtances favourable to their growth and proſperity. Almoſt all the French manufactories of hard ſoap are ſituated in the Southern provinces, on the coaſts of the Mediterranean, and particularly at Marſeilles; where, beſides being ſeated in the heart of the countries which produce olive oil, they poſſeſs the additional advantage of being able to keep up an eaſy communication with Alicant, Carthagena, and the other countries which furniſh them with ſoda. The manufactories of ſoft ſoap, on the contrary, have fixed their ſeat in the North of France, in the heart of the provinces where the culture of the colza, the turnip, the hemp-ſeed, and other obaginous grains, are moſt extenſively eſtabliſhed, and near to the ports habitually frequented by the merchants who ſupply us with pot-aſh.

Although the manufacturers of Marseilles supplied commerce with a quantity of soap sufficient for all its demands, the consumers shewed no curiosity to become acquainted with the processes used in the manufacture of this necessary, being accustomed to consider it as an article which might always be had of the merchants; but when, in the year 1793, they felt the want of it, every body was able to comprehend that there would be some advantage in being able to manufacture for themselves what they could not dispense with. Soap might be made without employing any other substances than such as are generally thrown away as useless in house-keeping; and this domestic manufacture might be carried on in the small way without requiring any more complicated apparatus than the washing with lye, which is so commonly practised in house-keeping. But an acquaintance with the requisite processes was wanting: these are described in the course of the present section, where the reader will also find described methods for composing easily, and at small expence, saponaceous liquors, which may supply the place of soap. We must first consider the manner in which the manufacture is carried on in the large way.

§ I. *Of the Manufacture of Soap in the large Way.*

We shall first treat of the hard, and afterwards of the soft soaps.

Article I. *Of the Manufacture of hard Soap.*

The work-shop of the soap-maker should be provided with *bucking-tubs*, for preparing the alkaline lye, with coppers for boiling the soap, with troughs,

troughs, or veſſels, into which the ſoap is poured after it has been boiled, and ſome other utenſils, which ſhall be mentioned as occaſion requires.

The ſoap-maker muſt know how to prepare lyes of different degrees of ſtrength, to manage the copper while the ſoap is boiling, and when this operation has been performed, to treat his ſoap in the proper manner for reducing it to the ſtate in which it is when commerce takes it out of his hands to diſtribute it among the conſumers.

It would be difficult to add to the perſpicuity and accuracy with which theſe ſubjects are treated by the Citizens Pelletier, Darcel, and Lelièvre. We ſhall therefore tranſcribe this part of their labours.

Of Bucking-Tubs.

The bucking-tubs, or veſſels in which the lyes are mixed, vary according to the magnitude of the eſtabliſhment.

In ſmall manufactories the bucking-tubs are generally wooden tubs, hooped with iron, and placed ſeparately upon treſtles, with a trough below, or they are mounted upon gauntries, in the ſame manner as the manufacturers of ſalt-petre diſpoſe their tubs for the purpoſe of lixiviating the earths which contain the ſalt. Theſe tubs are perforated near the bottom to facilitate the efflux of the lye; and, that it may be ſtopped at pleaſure, a ſpiggot of wood is adapted to the hole. Several of theſe tubs are placed in the ſame line, and they are ſupplied with clean water by pipes from above. This diſpoſition facilitates the labour in making the lye. A trough is alſo conſtructed below, and on the foreſide of the tubs, which receives the lye as it runs out, and from

whence it is conducted into ſuch or ſuch a reſervoir, according as it is intended to receive the firſt, the ſecond, or the third lye.

In large manufactories the bucking-tubs are conſtructed of brick-work; they are each nearly five foot ſquare, and about four foot and a half high: near the bottom there are wooden ſpiggots, which are drawn out according to the nature of the lye that is to run; and, in order to receive it, a reſervoir is made in the earth below the tubs, with partitions, that the different lyes may be kept ſeparate from each other.

Of the Coppers, or Boilers.

The boilers which are uſed in manufactories of ſoap are of a peculiar conſtruction. Only the bottom is of metal, and they terminate above in brick-work, with a coating of mortar. This bottom, which is generally made of copper, or Swediſh iron plates, and of a rounded form, has a rim, or edge, which is turned outward, and flattened like the brim of a hat; ſo that when the bottom is placed on the furnace, the rim projects full half a foot beyond the brick walls of which the furnace conſiſts; and this rim is afterwards covered with the bricks which complete the arch of the furnace. By this means, the rim of the bottom is entirely covered in with maſonry, and the boiler, the upper part of which conſiſts of brick, ſtands perfectly firm and immoveable. As, according to this mode of conſtruction, the boiler cannot be heated but by the bottom, ſome have imagined that, if they were made entirely of copper, the heat might circulate all round the boiler,

boiler, which would be a great ſaving of fuel; but there muſt be ſome more important conſiderations that have determined the ſoap-manufacturers to prefer the ſpecies of boilers which they have adopted. Such at leaſt appears to us to be the caſe, for the following reaſons.

In the firſt place, when oil or tallow is kept in veſſels of copper, it attacks the metal at thoſe parts where it is expoſed to the contact of the air, that is to ſay, towards the edges of the veſſel, and the quantity of verdegris which is thus formed cannot but be conſiderable. Thus when ſoap is boiled in veſſels entirely compoſed of copper, an admixture of verdigris is unavoidable, eſpecially if rancid oils, &c. be employed; and this verdegris, which remains in the ſoap, gives it a tinge more or leſs deep, which does not pleaſe the conſumer. This inconvenience is avoided by conſtructing the ſuperior of the boiler with brick.

Secondly, if the fire circulated all round the boiler in which the ſoap is prepared, the heat might become too violent at the end of the operation; that is to ſay, when the ſoap is already boiled; for in that ſtate it adheres eaſily to the boiler; but this inconvenience cannot enſue with boilers the bottoms of which are only expoſed to the direct action of the fire; for at this part of the veſſel there almoſt always remains ſtill a quantity of lye, which ſerves the purpoſe of a balneum mariæ to the ſoap which ſwims at the top.

Theſe two conſiderations may probably have been ſufficient to induce the ſoap-manufacturers to give the preference to that ſpecies of boiler which they at preſent employ.

The ſoap-manufacturers adapt ſtill to the bottom of their boilers a pipe, two inches and a half in diameter, which they uſe for drawing off the exhauſted lye which remains at the bottom of the boiler under the ſoap. If ſoap were to be boiled in a copper which was not provided with ſuch a pipe, the exhauſted liquid might be drawn off by means of a ſyphon made of tinned iron.

TO BE CONTINUED IN OUR NEXT.

XLIII. *On a new Method of preparing the Acetic Acid. By Citizen* BADOLLIER, *Chartres.*

FROM THE *ANNALES DE CHIMIE.*

THE proceſs of Citizen Badollier conſiſts in diſtilling with the ſand-bath, in a retort of glaſs adapted to a receiver, a mixture of equal parts of ſulphate of copper and acetite of lead.

For examining the products Citizen Badollier made uſe of the pneumato-chemical apparatus. During the operation, he obtained only a ſmall quantity of elaſtic fluid, which he diſcovered to proceed from the dilated air contained in the veſſels. This air, ſubmitted to the operation of proper re-agents, exhibited no ſigns of carbonic acid. As he ſuſpected that his acetic acid might contain a portion of ſulphuric acid, he tried it with

with a solution of muriate of barytes, which produced no precipitation from it.

It is to be remarked, that the distillation is performed very rapidly, and with a very moderate heat; that the acid obtained in this manner has nothing of an empyreumatic smell; that it is inferior neither in quantity nor in quality to that obtained from the distillation of the acetite of copper, and that it does not contain, like that obtained by the former process, a portion of decomposed acid, which communicates a very disagreeable smell to the rest. Independent of the saving of time and fuel, the price of the acid prepared by this new method is to the price of that obtained by the distillation of the acetite of copper as one to four.

XLIV. *List of Patents for Inventions, &c.*

(Continued from Page 216.)

JOSEPH WILKES, of Measham, Derbyshire, Esquire, and THOMAS JEWSBURY, of the same place, Cotton-manufacturer; for their new method of making paste, to be used in weaving and sizing of callico, and for pasting paper, &c.

Dated January 16, 1801.

JOHN STEVENS and THOMAS ANGELL WHITE, both of Plymouth, Devonshire, Coal-factors; for their new method of making bricks.

Dated January 16, 1801.

BENJAMIN

Benjamin Batley, of the parish of Streatham, Surrey, Merchant; for a further new method of curing and preserving herrings and sprats, which will also extend to the curing and preserving of other fish.

Dated January 20, 1801.

Robert Vazie, of Down's-street, Piccadilly, Middlesex, Gentleman; for an improvement in the constructing, construction, and application of a gun, by means of removing the touch-hole from the side to the centre of the but-end of the barrel, and forming therefrom a cylindrical communication, &c.

Dated January 23, 1801.

George Medhurst, of St. James's, Clerkenwell, Middlesex, Engineer; for a new-invented compound crank for changing a circular motion into a rectilinear one, and *vice versa*, which is applicable to various mechanical purposes.

Dated January 27, 1801.

John Longman, of Pentonville, Middlesex, Organ-builder; for new-invented improvements in the construction of barrel-organs, to prevent them from getting out of order; and that another musical instrument or instruments may be internally united or attached thereto, and to play with the same barrel.

Dated January 27, 1801.

Printed by Nichols and Son, Red-Lion-Passage, Fleet-Street, London.

REPERTORY OF ARTS AND MANUFACTURES.

NUMBER LXXXIII.

Printed by NICHOLS and SON, Red-Lion-Paſſage, Fleet-Street, London.

XLV. *Specification of the Patent granted to* JOSEPH GASTON JOHN BAPTISTE COUNT DE THIVILLE, *of Piccadilly, in the County of Middleſex; for certain new Methods of giving an independent moving Power to all Machines, by Means of Hydraulick Engines; and alſo of conſtructing and employing ſeparately ſeveral of their Parts, ſuch as Wheels, Piſtons, and Apparatus for reducing Friction, upon new Principles.*

Dated February 5, 1801.

WITH A PLATE.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that in compliance with the ſaid proviſo, I the ſaid Joſeph Gaſton John Baptiſte Count de Thiville do hereby declare, that my ſaid invention conſiſts in the application of certain hydroſtatical principles not at all or but little known till now, which, contrary to the laws of ſtatics in ſolid bodies, give to incompreſſible fluids the property of riſing almoſt ſpontaneouſly

above the place from which they have fallen. Without accounting for the caufes, I will confine myfelf to effects founded on experiments, and give fome fpecimens of thefe principles, and of the confequences refulting therefrom. Let Fig. I be an empty tube, and ftopped at bottom or top air-tight. If it be immerfed into water and fuddenly opened, the fluid will rife to *a*, fall to *b*, rife again to *c*, and fo on till it fix itfelf at *d*; which is the level of the fluid. Let Fig. 2 be a vertical fection of a cheft faftened in a large refervoir or pond. Let the front part *a b* revolving at *i* be in the pofition *i* 2, if it fall fuddenly at *i* 3, the water will rife above its level, and a portion will flow out of the cheft. Let the front part *a b*, in the fituation *i* 4, be counterpoifed by a pendulum V O, in fuch a manner that, either at work or at reft, the gravity of V O be in the fame conftant ratio with the gravity of *a b*, then the leaft poffible power impelling on O, will communicate motion to *a b*, by the rods B and X, which have a common centre at V. If the motion is alternate and regular, *a b* going up and down from 3 to 5, the water will rife as before, and enter an upper refervoir *q*; befides the front part *a b* ftriking or impelling on the furface of the fluid at *r*, will form a wave, which will be able to raife a body Y, immerfed at fome diftance, and the water withdrawing will abandon the body to its own weight, which effect may be productive of a power. If the water is prevented from going out of the cheft, by the front part being lengthened as at *c*, this front part being alternatively and gradually loaded with, and unloaded from, the weight of water, will produce a gradual and difpofable power, which will be ftill greater

greater if the cheſt be ſituated out of the reſervoir, communicating with it by its back part only. If an empty veſſel K intercept that communication, the valve at 7 being ſuddenly opened, the water will riſe to 9. If 7 be ſhut, and the valve 6 opened at the moment the front part *a b* falls from *i* 2, to *i* 3, 9 will fall in 8, and ſo on, ſo that if a body is immerſed in the veſſel K, it will produce power by going freely up and down. Let a cheſt Fig. 3, with an aperture *x* in its circular bottom be placed in a reſervoir, if that cheſt be ſuſpended like a pendulum at A, or bearing like a cradle on fixed beams *a b*, or like a mangle on the top of rollers *c d* without centres; if I move the cheſt alternately and regularly in any of thoſe manners, or otherwiſe, the water will alternately riſe out of the cheſt, and enter the upper reſervoirs *y* and *z*. If the ſurrounding water be found an obſtacle to the motion, the cheſt may be placed out of the reſervoir, and be ſupplied by a ſyphon above, or a flexible pipe under the cheſt, as ſeen at *q* and *f*, Fig. 5. That pipe correſponding with the aperture *x*, Fig. 3. Four or more of theſe cheſts, *a*, Fig. 4, may likewiſe be eſtabliſhed on a floating circular timber work with apertures at *x*; the intervals *b* between the cheſts being empty and inacceſſible to the water, as ſeen in the ſection Fig. 4, No. 2. Then if a circular and alternate motion from 1 to 2 round the point A, be given, the water will riſe and flow in the parts *c*, which belong to an upper reſervoir *d*. Let Fig. 5 be a cheſt with flat or circular bottom hanging at *y*, to a beam *y z*, turning at X upon ſtandards B. At *z* hangs another cheſt P ten feet high, and only a few inches thick, immerſed in the water, X *y* being to X *z*, as one to ten. If A contains

100 cubic feet of water, P ought to contain little leſs than 10 feet. The bottom of A being nearly level to the ſurface *l* of the reſervoir; if the water enters gradually in A, the cheſt will deſcend in O, and raiſe P to S. P being ſuſpended at *x*, and ſo contrived that its upper part when filled be ſomewhat heavier, and when empty ſomewhat lighter than its under part, the conſequence will be that when P is diſengaged it turns at *x*, diſcharges its water into R, and takes again its former upright ſituation. But it muſt be obſerved, that of whatever materials P may be conſtructed, it muſt loſe a great part of its weight when in water, for inſtance, 100 pounds. In order to remedy that real diſadvantage, I fix in the building a veſſel I, containing 100 pounds of water on a ſurface only a few inches deep. To that veſſel is fixed an upright pipe 2, united by a flexible pipe at 3 to another pipe 4, tied upon the part X z of the beam. Another pipe 5 containing 100 pounds of water is faſtened to the curved part of the beam; by that means the gravity which P loſes gradually, entering into water, is repaired gradually by the water entering the pipe 5, ſo that an inverſe ratio ſubſiſts conſtantly between P and 5. When A is arrived and faſtened at O, the ſluice or ſhuttle *a* of the reſervoir, and that *b* of the cheſt is opened, the front part T Figs. 5 and 6 upon which the water acts by its lateral preſſure being diſengaged, falls with an increaſing power according to what has been ſaid at Fig. 2; a rope or chain *c* fixed in K, turns a wheel H by means of a hook *i*, which catches the teeth of a ratchet *m*, one of the veſſels 5 is raiſed in *l*, turns in *x*, and makes the ſame effect as P, Fig 6.

Applications.

Applications. If I can raiſe a large quantity of water, for inſtance, at the height of one foot only, by the means ſeen in Figs. 2, 3, and 4, I can employ this water as an immediate power, acting on a common water wheel; but the power which I can derive from the gravity of A Fig. 5, being in the order of an arithmetical progreſſion, cannot act on machinery but by the mediate aſſiſtance of P, which raiſes the water to nearly 5 feet. I diſpoſe accordingly an overſhot breaſt-wheel Figs. 7, 8, and 9, in ſuch a manner that the water be conveyed in one or two rows of buckets *l*, by one ſingle or double trough *b*; the water enters the buckets at *x*; they are ſituated contrary to the uſual way; and their lower part is narrower than the upper part as ſeen in Fig. 9; the ſide parts are beveled or inclined ſo as to leave between them an interval *a* Fig. 9, by which the water is diſcharged when each bucket is arrived at X, Fig. 7 only, which diſpoſition increaſes conſiderably the power of the wheel; but in order to produce the beſt effect, the reſiſtance ariſing from friction ought to be reduced as much as poſſible; to that effect let A, Figs. 7, 8, and 10, be a cheſt traverſed by the gudgeon *b* of a wheel, to that gudgeon is fixed a hollow cylinder *d*; if the cheſt be filled with an incompreſſible fluid, and if beſides the cylinder diſplace a volume of that fluid, equal to the weight which in the uſual way is ſupported by the gudgeon, that weight will be totally tranſported from the gudgeon to the fluid, and the friction ariſing from gravity will be totally reduced. Inſtead of the cylinder *d* being fixed to the axis, it may be independent; the iron axis or even the wooden axletree, in that caſe turning on its periphery as ſeen in A 2, and A 3, Figs. 8 and 11.

If

If a wheel be to revolve horizontally like a mill-ſtone, the cylinder ought to be fixed either at the under part, or at the top of the axis. Theſe wheels, whichever of them I employ, muſt be provided with a cog wheel which turns a pinion, the axle of which is a crank, or another pinion with teeth upon half part only of its circumference; which teeth, catching alternately the upper and under teeth of a double rake, give the vibration to the cheſts or front parts by rods, which means are already well known. The power which is deſtined to put in motion theſe different machines, deſcribed in Figs. 2, 3, 4, 5, and 6, ought to be conſidered only as a regulator which gives the neceſſary velocity, engages and diſengages at pleaſure by any known means, and increaſes the effect in giving a regular and iſochronal motion. In witneſs whereof, &c.

Obſervations by the Patentee.

From what has juſt been ſaid in my ſpecification above, it may be concluded that the application of the foregoing principles may vary *ad infinitum.* At what height, in what quantity, and at what expence of power can the water be raiſed, are likewiſe liable to great variations, and can only be aſcertained by experiment on large ſcales, and in open water. Some parts of the objects above ſpecified have already had a ſort of publicity. About two years ago, I offered to the Royal Society a *memoir on friction, and on the means of reducing it.* I was induced to that ſtep by the advice of two of the moſt diſtinguiſhed members of

of the Society, one of whom very obligingly delivered it himſelf. The object of that memoir was to prove, by experiments, that, between fluids and ſolid bodies immerſed in them, there is neither friction nor abſolute reſiſtance. This principle, it is true, is in direct oppoſition to the doctrine adopted by the learned in philoſophy. I made likewiſe an application, to demonſtrate that the problem of a perpetual motion, though inconſiſtent with the laws of mechanics, was to be reſolved by the *phenomena naturæ*; and that, if it was poſſible to borrow from nature the materials with which it acts, and conſequently to produce effects ſimilar to thoſe which daily occur to our eyes, the problem would be reſolved. The ideas contained in my firſt memoir on friction having been deemed inadmiſſable, *a fortiori*, ſuch an idea as that now in agitation ſhould be put aſide, the ſcientific world having long ago pronounced ſentence of lunacy againſt thoſe who obſtinately attached themſelves to the purſuit of ſuch a chimera. Without diſcuſſing here the right which philoſophers, either individually, or united in ſcientific bodies, have to pronounce without appeal, or to fix a *nec plus ultra* to human knowledge, I will confine myſelf to my ſubject; and, addreſſing myſelf to the learned, as a man warmly intereſting himſelf in the progreſs of arts and ſciences, as an obſerver who has ſpent much time in conſidering the ſubject, I take the liberty to ſay, to thoſe who maintain that there is friction and abſolute reſiſtance in fluids, they conſequently know what is the quantity of them under certain data. To ſuch I beg leave to propoſe the following problems:

On

On Friction in Fluids.

1. Let A Fig. 12, be a cylindric foot of solid matter, the weight of which is only one grain less than an equal volume of water, consequently about 50 pounds weight, that cylinder is supported by B. Let V represent the requisite power, to subdue the resistance which friction opposes to motion; which resistance, according to the admitted doctrine, is about a third of the weight.

2. Let another cylinder of the same matter and diameter be ten feet long, *ceteris paribus*: let the requisite power be represented by X.

3. Let both apparatus be totally immersed in water, the power in that new situation being represented by Y if the length is one foot, and by Z if it is ten feet.

What are the ratio's between V and Y, between X and Z, and between Y and Z?

Resistance of Fluids.

1. Let a cubic foot in the same circumstances as before, *i. e.* weighing about 63 pounds, be freely immersed in water, the power to move it either horizontally or perpendicularly, be represented by X.

2. Let another solid body be 10 feet long, *ceteris paribus*. The power represented by Y.

3. Let another solid be two feet every way, *i. e.* 8 cubic feet, *ceteris paribus*. The power represented by Z.

What are the respective ratios between X Y and Z?

I have used the expression of absolute resistance, to indicate that the velocity of the bodies in motion,

tion, or their reſpective velocities, have no relation at all with the power, which ought to be conſidered only as deſtined to ſubdue the reſiſtance, without any regard to time, *i. e.* whether the effect takes place in the ſpace of two hours, or in that of two ſeconds.

Perpetual Motion.

Without prejudging any thing upon the principles I have introduced in my ſpecification, which principles I conſider as a theorem from which every one may draw the corollaries; I will confine myſelf within the limits I have preſcribed, and propoſe the following problem. Let A, Fig. 13, be a wheel or cylinder turning on its gudgeon *b*, *c c c* is an aſſemblage of ſheets of any material or ſtuff; theſe ſheets paſs between thin plates or wires faſtened in a fixed box *i i*, at *o o* they paſs freely between ſmall cylinders or rollers, turning in another fixed box V. Inſtead of being ſo ſeparated, they may be preſſed cloſe to each other by paſſing between two rollers *u u*; thus the apparatus being ſo diſpoſed, and the level of the water being as at *d e*, I ſay the phenomenon of ſpontaneous aſcent of fluids in capillary tubes or ſpaces, ought to take place between the ſheets at *i i*; and it ought not to do ſo at *o o*, or at *u u*, by their being too cloſe to, or too diſtant from, each other. That being eſtabliſhed, I repreſent by Y the power acquired by the aſcent of the fluid at *i i*; I repreſent by Z the mechanical reſiſtance, occaſioned by the rubbing of the ſheets againſt the cylinders at *o o*, or by their preſſure at *u u*. Now I aſk how, and at what point the laws which preſide over the phenomena of nature at *i i*, and thoſe

which regulate the mechanical effect at *o o*, or *u u*, coincide fo as to determine a conftant ratio between the power and the refiftance; and finally what is the ratio between Y and Z.

It is obvious that if Z is greater than, or equal to Y, the machine will remain immovable. If on the contrary Y is greater than Z, the machine once put in motion will never ftop.

I abftain from any comment on the foregoing problems. I muft only add that I do not think I am too fanguine in my expectations, in announcing that a candid and impartial examination of my doctrine may be productive of fome advantage to the fciences; and that the arts will derive a great benefit from a proper application of the principles which I have eftablifhed in the foregoing fpecification. That doctrine and thofe principles are explained at full length in a treatife, and in different memoirs which I have compofed, and intend to publifh, on hydroftaticks, and on the motion and refiftance of fluids; in which I have carefully avoided all fcientific calculations, formulæ, &c. and have fubmitted all my hypothefes to the teft of experiment. I fhall fubmit thofe philofophical opufcules to the inveftigation of the learned in natural philofophy, as foon as a good verfion from the pen of an abler tranflator than I am fhall be completed.

Note relating to Figs. 7, 8, *and* 9.

Independently of the advantages refulting from the wheel Fig. 7 lofing no water at all, another advantage, which is not evident at firft fight, deferves to be explained. To that effect, let A, Fig. 14, reprefent the actual way of filling the buckets; and

B,

B, the method I am now propoſing. If theſe two buckets are placed at equal diſtance from a common centre of gravity C, and filled with the ſame quantity of water, it is obvious that, by the poſition of that water in the buckets, B acts more powerfully than A, and conſequently will overpower it upon that centre. If, beſides, the impulſe or ſhock of the water on ſuch wheels is worth being reckoned, that impulſe acting at *b b*, at a greater diſtance from the common centre than at *a a*, its power will conſequently be greater.

Note relating to Figs. 5 and 6.

Four, ſix, or more cheſts either rectilinear or curvilinear, acting as ſeen in Figs. 5 and 6, may be diſpoſed as two or three pair of ſcales. The rods which communicate the motion may be engaged or diſengaged at pleaſure, ſo that when one ſcale of the firſt pair is in motion to be emptied, the other ſcale is at reſt; the firſt ſcale of the ſecond pair is acting by its gradual gravity, and falling from A to O, and the other ſcale is empty and riſing from O to A, and ſo on. The whole ought to be ſo calculated that the water may ſucceſſively, and almoſt without interruption, flow out of one of the upright cheſts P, and that the moving power has only one cheſt to move. It is underſtood that the wheels intended to be the moving power belong to any machinéry, ſuch as corn or paper-mills, pump work, or any other machine whatever.

The following allegations, if they turn out to be founded on facts, will prove much in favour of my opinion, that there is no friction between

fluids and ſolid bodies. If a copper-bottomed ſhip is examined (which I never had an opportunity to do) as ſoon as it arrive from a long voyage, I think it will be ſeen,

1, that the metallic brightneſs has been reſtored to the copper by the inceſſant percuſſion of the water.

2, that, that effect is the greateſt on the parts which are the neareſt to the ſurface of the water.

3, that it decreaſes in proportion to the diſtance from that ſurface.

4, that on all the parts which form the bottom of the ſhip (at which parts the friction, if any, ought to be more ſtrongly felt, owing as much to their almoſt horizontal ſituation as to the column of water bearing heavier upon them, in the ratio of its depth,) the copper is totally covered with verdegris, conſequently has experienced no friction at all; ſince an inceſſant motion, during ſix months or more, has not been able to produce an effect equal to that which could have been attained by ſlightly rubbing with the finger during a few minutes.

5, if a piece of copper be taken from the part near the ſurface of the water, and another near the keel, it will be found that the firſt has loſt of its original thickneſs, and that the ſecond has loſt nothing but by the chemical operation of the acid of the water acting upon the copper.

If theſe aſſertions be confirmed by facts, they will be ſtrong arguments againſt the ſupporters of the doctrine of friction in fluids.

XLVI.

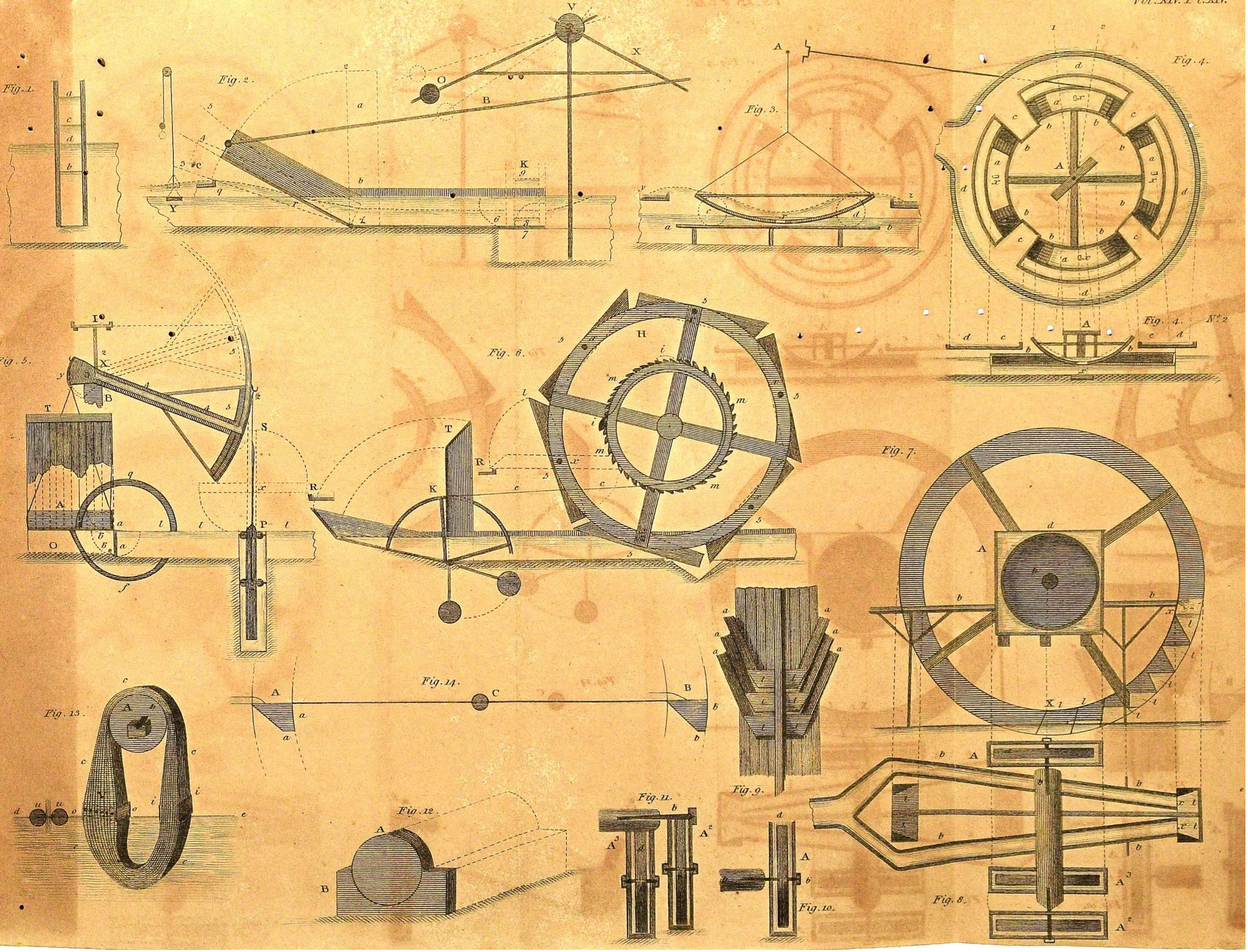


Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 4. N.º 2
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 8.
Fig. 9.
Fig. 10.
Fig. 11.
Fig. 12.
Fig. 13.
Fig. 14.

XLVI. *Specification of the Patent granted to Mr.* Samuel Gratrix, *of Hulme, in the Parish of Manchester, and County of Lancaster, Callico Printer and Dyer; for his new-invented Process and Method of Dying and Staining Colours upon Cotton Cloth, Linen Cloth, and Cotton and Linen Cloth mixed.*

Dated July 17, 1799.

WITH A PLATE.

To all to whom these presents shall come, &c. Now know ye, that in compliance with the said proviso, I the said Samuel Gratrix do hereby declare, that my new-invented method of dying and staining different colours upon cotton cloth, linen cloth, and cotton and linen cloth mixed, is particularly described and performed, in the manner following; that is to say: To dye a black upon cotton cloth, linen cloth, and cotton and linen cloth mixed, I take tar, iron liquor of the very best quality, adding to each gallon thereof, three quarters of a pound of fine flour, and by boiling bring it to the consistency of a thin paste. I put the liquor or paste above mentioned into the tub marked No. 3, belonging to the machine used in this process, a section and horizontal plan of which, with reference to, and description of, the several parts whereof, is hereunto annexed. (See Plate XV.) The goods intended to be dyed are wound upon the roller No. 14, and passed through the liquor or paste above mentioned, betwixt the two rollers 7 and 12; thereby compleatly

compleatly ſtaining or dying the whole maſs or body of the cloth. I paſs them into a very hot ſtove or drying-houſe till dry. I take cows dung, put it into a large copper of water about ſcalding hot, and mix it well together, through which I paſs the piece of cloth until it be thoroughly ſoftened. Note: the quantity of dung, and the time neceſſary in this proceſs, depend upon the ſubſtance of the cloth, and the quantity of the paſte or liquor imbibed in it. I take and waſh the goods, ſo dunged, extremely well in water. I take a quantity of madder, or logwood, or ſumach, or any two of them, or all of them mixed together, as the ſtrength of the cloth and nature of the colour may require, and put them into a copper, or tub of hot water; then enter the goods before mentioned into this liquor, and keep wrincing or moving them therein, until I have brought them up to the ſtrength of colour required. I have the goods again well waſhed and dryed. Note, for dying black, it will be proper to paſs the goods a ſecond time through the above operations; adding more or leſs of the dying-woods as before. Note alſo, that if, after the above operations and the ſhade of colour is too full, or too much upon the red hue, it will be neceſſary to give them a little ſumach, and then run them through a liquor made from iron and owler *, or alder bark. Another method of dying black: I take common iron liquor, and add three quarters of a pound of fine flour; and by boiling bring it to the conſiſtency of a thin paſte, or, inſtead of flour, I add glue or linſeed, or gum, or any two, or all of them mixed together, till it is

* Compared with the record in the office.

brought

brought to a proper thicknefs. I then pafs the goods through the machine, and follow the before-mentioned operations. To dye olives, bottle greens, purples, browns, cinnamons, or fnuffs, I take common iron liquor, or common iron liquor with allum diffolved in it, or common iron liquor with allum and faccharum faturni diffolved therein, in quantity of each, according to the fhade of colour wanted, made into a pafte or liquid, by adding flour, gum, glue, linfeed, or one or more of them as before. I then put the liquor or pafte above mentioned into the tub marked No. 3, belonging to the machine before defcribed, and pafs the goods fo intended to be dyed through the machine in the fame manner I have defcribed for dying black. I take them from the machine, and hang them up in a very cool room, where they remain till thoroughly dry. I take cows dung, put it into a large copper of hot water, and mix it well together; through which I pafs the cloth or goods until thoroughly foftened, the quantity of dung and time requifite, being proportioned as before. The goods after this procefs being well wafhed, I take a quantity of liquor made from madder, logwood, fumach, fuftick, brazil, wolds, quercitron bark, peach wood, or other woods, to produce the colour wanted, or any two, or more of them; and, in cafe I fee it neceffary, I dilute this liquor with water, according to the fhade or fullnefs of colour I want to dye. I then work the goods through this liquor very well; after which I pafs them through cold or warm water, according to the colour, the proper application of which is well known to dyers, adding a little allum, copperas, or roman

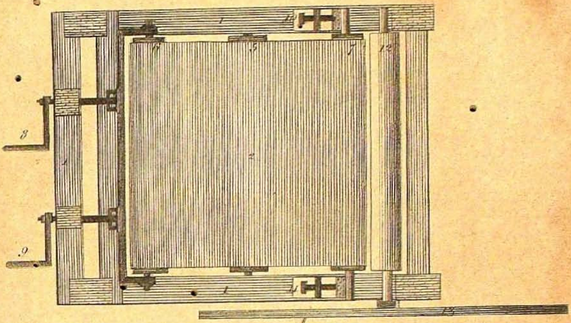
vitriol,

vitriol, or two or more of them, firſt diſſolved in water. I then waſh them off in warm water, and dry them. Note, if the colour is not ſufficiently full, I repeat the ſame operations, till it is brought to the ſhade required. To dye crimſon, red, orange, or yellow: I take red liquor, ſuch as is generally made from allum, ſaccharum ſaturni, or ſuch like ingredients, and dilute it with water, according to the ſtrength or ſhade of colour I want to dye, bringing it to the conſiſtency of a paſte or liquid, as before deſcribed. Then paſs the cloth through the machine, which being dryed in a cool room, paſs it through the operations of dunging and waſhing as before. I take a quantity of liquor, made from cochineal, madder, peach-wood, brazil, logwood, wolds, fuſtic, ſumach, or any two or more of them proportioned in ſtrength to the ſhade of colour I want to dye, and work the goods through this liquor very well, till I have brought them to the ſhade of colour required; after which I waſh them in cold or warm water, and dry them. In witneſs whereof, &c.

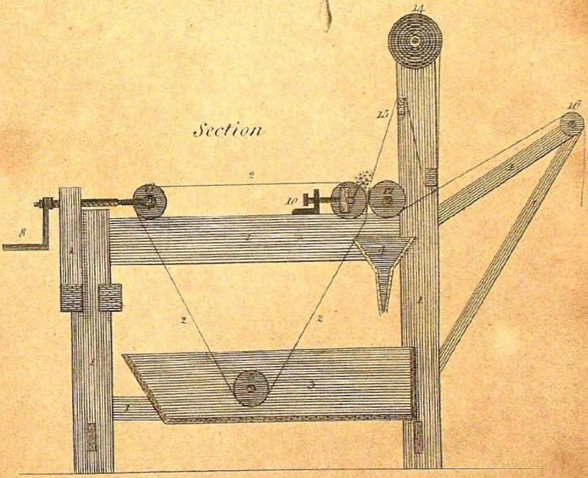
Reference to, and Description of, the Machine.

No. 1, the frame. 2, The cloth or hatting which conveys the paſte or liquor to the piece of cloth intended to be dyed. 3, The tub made to contain the paſte. 4, Another tub, which receives the ſuperfluous liquor or paſte from the piece, and conveys it into No. 3. 5, 6, and 7, are three rollers, round which the hatting runs; paſſing through the tub of liquor, No. 3. 8, and 9, two ſcrews,

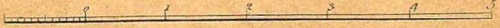
Horizontal Plan



Section



Scale of Feet.



ſcrews, for the purpoſe of tightening the hatting. 10, and 11, two ſcrews which preſs the roller No. 7, againſt the roller No. 12, betwixt which the piece paſſes. 12, A roller on which the fly-wheel No. 13 is fixed, which puts the machine in motion. 13, The fly-wheel. 14, The roller on which the piece is wound. 15, The piece paſſing through the liquor, and betwixt the rollers 7, and 12. 16, Another roller which draws the piece from the machine; by a ſtrap worked from a pulley, on the roller No. 12.

XLVII. *Specification of the Patent granted to Mr.* EBENEZER PALMER, *of Saint Mary Cole, Cheapſide, Stationer; for an improved Mode in binding Books, eſpecially Merchants Account Books.*

Dated December 30, 1800.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that in compliance with the ſaid proviſo, I the ſaid Ebenezer Palmer do hereby declare, that my ſaid invention of an improved method in binding merchants' account books is deſcribed in manner following; that is to ſay, by the addition of a certain metallic hinge or chain, contrived and made in the following manner:

Firſt. There are certain various ſmall bars of metal, or compoſition of metals, about the thickneſs of a ſhilling, or more, according to the ſize and thickneſs of the book to be made, the length

 of

of each ſuch bar being from half an inch to ſeveral inches long, in proportion to the ſtrength required in the back of the book.

Secondly. At each end of every ſuch bar of metal is made a pivot, by being filed down, or otherwiſe, and which are of different lengths, alſo in proportion to the thickneſs of two links, which they are to receive.

Thirdly. There are a certain number of links, made rather in an oval form, to the ſaid hinge, each of which contains two holes, according to the ſizes of the pivots they are to go on, which links are of the ſame metal as the hinge, or a compoſition of metals, as is judged neceſſary; each of the ſaid links being nearly the length that two of the above deſcribed bars are wide.

Fourthly. When ſuch metallic pivots are prepared, the afore-mentioned links are then rivetted on thoſe pivots, each pivot receiving two links, and thereby hold the ſaid hinge together, on the principle of a link-chain or hinge.

Fifthly. There are two holes, or more, of different ſizes, as required in each bar of the hinge or chain, by which means each ſection of the book is ſtrongly faſtened to the ſame; which hinge, ſo faſtened, operates with the back of the book, when bound, in ſuch an improved manner that thereby occaſions the ſaid ſections to open in ſuch a manner as to bring them on a parallel with each other, and in conſequence thereof admit of the ruled lines being written into, even cloſe to the back, without any inconvenience. In witneſs whereof, &c.

XLVIII.

XLVIII. *Specification of the Patent granted to Mr.* Benjamin Batley, *of Streatham, in the County of Surrey, Merchant; for a new Method of curing and preserving Herrings and Sprats.*

Dated September 11, 1800.

TO all to whom these presents shall come, &c. Now know ye, that I the said Benjamin Batley, in compliance with the said proviso, do hereby describe and ascertain the nature of my said invention to be as herein-before set forth, a new method of curing and preserving herrings and sprats. And I farther declare the operation to be performed in manner following; that is to say: After severing the head, and taking out the entrails of the herrings or sprats, salt the body of the fish with bay or rock, or the common salt, in the casks, (if not sufficiently salted as sea sticks,) but the bay or rock salt is preferable, as the common is more apt to absorb the pickle, and occasion the fish to rust. In the next place pack the fish in a cask, in the usual way, and between every layer sprinkle a small portion of salt, and also pickle, sufficient to cover the fish. Such pickle to be made with one pound of bay salt, four ounces of saltpetre, and from two to four pounds of melasses, (to suit different palates,) to a gallon of spring-water, if to be procured, and boil the same till the whole of the ingredients are dissolved. (River water may answer the purpose, but spring water is preferable.) When the fish are so packed, leaving a vacuum between two

 and

and three inches of the head of the caſk, for a full portion of pickle, then let the caſk be headed up, and properly coopered, with a cork-hole, either in the head or centre, through which may be poured a farther ſupply of the pickle, for the preſervation of the fiſh; and when the herrings or ſprats, but particularly the latter, are intended for travelling, it may be adviſeable to put a falſe top, bored with holes, between the fiſh and caſk-head, in order to prevent their being too much ſhaken: the ſame proportion of any ſugar might be uſed as a ſubſtitute for melaſſes, but the extra price would probably be conſidered as an impediment; and from one to three months ſhould be allowed for curing, in order to give the fiſh a full flavour before they are uſed, ſmoaked or dried. The above pickle would anſwer for flavouring the fiſh in their original ſtate, if needful; but, on account of the oil and filth contained in the heads and roes, the preferable mode of curing and preſerving the body of the fiſh is by ſevering the head from, and taking out the entrails, as the only effectual means of eradicating the noxious qualities which would otherwiſe adhere to them. And, in curing ſprats, it is expedient to ſprinkle a larger quantity of ſalt in proportion between each layer than is requiſite for the herrings when packed in the caſk. And as the ſprat caſks will ſeldom exceed ten gallons, a vacuum of about one inch from the head for caſks of that dimenſion will be ſufficient. In witneſs whereof, &c.

XLIX.

XLIX. *Account of the Method of preparing Opium from Poppies grown in Great Britain, equal in Quality to the best foreign Opium.* By Mr. THOMAS JONES, *of Fish-street Hill.*

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

A Premium of Fifty Guineas was adjudged to Mr. JONES for this Communication.

IN the summer of 1794 I cultivated a considerable number of White Poppies (entitled in the New London Pharmacopœia, Papaver Somniferum, and, in another place, Papaver Hortense semine albo), when a few of the heads or capsules having been broken off by the wind, I observed at the extremity of the stalks a substance in every respect resembling Turkey Opium. This accidental circumstance bringing to my recollection its method of production, as related in the Encyclopædia and elsewhere, I wounded a considerable number of them with my penknife, and, in the course of the day, collected a small quantity of the above-mentioned substance. As this circumstance took place while we were cutting lavender, it happened that an old experienced servant, who was afterwards to distil it, was directing and assisting, and we agreed that it was probably in effect equal to, and was certainly more pure than any we had ever seen.

From this period I have never entirely lost sight of the object I am now to consider; but, on account

count of various avocations, and particularly my Rhubarb plantation, which at this time required all the attention I could well ſpare, it was not in my power to engage in an untertaking of ſuch magnitude; and more eſpecially on a ſcale ſo extenſive as that which I had already determined to adopt, under a perſuaſion that experiments, when more confined, are for the moſt part fallacious.

As preparatory, however, I have not failed every year to repeat the operation, at once eſtabliſhing its practicability, and availing myſelf of many advantages which can only be derived from obſervation and experience.

The incloſed certificates will inform the Society that at length my plan has been carried into execution, but not with the degree of ſucceſs that ought, and might have been expected to attend ſo large and expenſive an experiment.

It muſt be confeſſed, that had I been at all aware what an almoſt Herculean labour I was about to encounter, I really ſuſpect whether my reſolution would have been equal to the taſk. Leſt, however, this ſhould diſcourage others from proſecuting this object, it is neceſſary to be more explicit.

Difficulties, and ſuch indeed as are conſiderable, muſt neceſſarily attend moſt undertakings which have been hitherto unattempted; but the diſappointments I ſuſtained, though more numerous than generally fall to the ſhare of a perſon under ſuch circumſtances, and more aggrevated, did not all ariſe out of the undertaking itſelf, but from cauſes, ſome of which may be eaſily guarded againſt in future, while others may never again occur.

Two

Two years have passed in producing what, I flatter myself, the Society will consider deserving their premium, particularly if am I enabled to render the operation much more simple than may at first sight be supposed.

The claimant, I observe, is required to submit to the Society his particular method of cultivating the Poppies. As the mode adopted in the present instance arose rather from necessity than choice I must go back as far as the autumn of 1797, to show how it happened.

Five acres of ground and upwards, situated in the parish of Enfield, in the county of Middlesex, I appropriated to this experiment, at the period above mentioned; which, being ploughed several times previous to the following March, were then sown broad cast; and the weather proving favourable, the seed soon vegetated, and appearances were very promising. From the neglected state of the land, however, to which I was unfortunately a stranger, such a profusion of weeds sprang up among them, that, after many fruitless efforts at recovery, I was under the mortifying necessity of ploughing them all up together. This circumstance not taking place till the latter end of April, the season for sowing was elapsed; and as to cropping my field with oats or barley, a measure very strongly recommended to me, I considered it as a deviation from my original purpose, and therefore, without paying any attention to it, gave the field a summer-fallowing, conceiving the Poppies might be sown with equal and perhaps greater advantage in autumn.

Finding that the broad-cast method of sowing precluded the possibility of hoeing where the land is much infested with weeds, I now adopted a different

ferent mode, and drilled in the ſeed with a very ſimple yet efficient machine, which I purchaſed of Mr. Macdougal, of Oxford-Street: but, as the weather began to be very ſevere ſo early as November, and continued ſo with few intermiſſions, the ſucceeding March found me very little forwarder. Yet ſtill I perſevered, and once more reſolved to drill the whole five acres: they came up extremely well, and, as I expected, accompanied with innumerable weeds; but theſe by well-timed application were eradicated, though not without conſiderable difficulty.

I now thought mſelf ſecure; for nothing could aſſume a better appearance, till the beginning of May. Alas! I could not foreſee the cold and remarkably dry weather that enſued, and prevailed, I believe, for ſix weeks ſucceſſively. Hence the growth of ſome became ſtunted, and others were entirely deſtroyed; but happily ſome warm refreſhing ſhowers fell juſt time enough to reſcue the remainder.

From theſe I have procured upwards of twenty-one pounds of Opium, five of which, in compliance with the Society's requiſition, I have ſent for their inſpection and examination.

At one time I began to deſpair of even procuring this, comparatively ſpeaking, ſmall quantity, though it is not a fifth part of what I ought to have had, owing to the extraordinary rains and winds which we experienced through the whole of the ſummer months.

This recital, as I have before obſerved, ought on no account to intimidate others from a co-operation; for it is obvious, that the former inconveniencies originated in my own ignorance, whilſt

the latter depended upon the caufes that in all probability may never happen again.

Mr. Ball, in a letter publifhed in one of the volumes of the Society's Tranfactions *, advances an opinion which I confider as very fallacious, refpecting the quality of land adapted to the growth of Poppies. He feems to be very little concerned about this point, and hints the probability of their being cultivated almoft every where. I well know that Poppies, like many other vegetables, will grow in foils of any defcription; but of this I am fully affured, that, like the reft, they have their particular and favourite foil, viz. a fandy loam, and that the better this is, the more advantages will accrue to the cultivator. For it fhould be confidered, that, in bad as well as good ground, the fame expences of cultivation, fcarification, and collecting, will be incurred, for perhaps a fourth fhare of the produce.

There is alfo another error in the fame communication, which, having a tendency to miflead, ought to be pointed out. He tells us, to ufe his own words, "That, by a calculation he has made, fuppofing one Poppy growing in one fquare foot of earth, and producing only one grain of Opium, more than fifty pounds (I fuppofe he means, of courfe, apothecaries weight) will be collected from off one ftatute acre of land." Now, as there are no more than 43,560 fquare feet in an acre, and allowing one grain for each, the produce can be no more than ninety ounces and fix drachms. This calculation appears to me to be as much in the extreme one way, as that of Mr. Ball is in the other. The medium is moft probably neareft the

* See our fixth volume, page 401.

 truth;

truth; but upon this point I cannot at preſent ſpeak with any degree of preciſion on account of the ſcattered ſituation of my crop, and the extraordinary intemperance of the laſt ſeaſon. Judging, however, from the number of heads we perceived, and comparing them with the total quantity, they ſeem to have yielded three-fourths of a grain each, upon an average, large and ſmall.

I ſhall now lay before the Society ſome general remarks on the cultivation of Poppies, and then conclude with ſubmitting a few hints and directions reſpecting the preparation of Opium.

Having a tap-root, their ſize will conſequently be proportionate to the depth of earth they are enabled to penetrate. Hence the neceſſity of land that will admit of deep ploughing. The fineneſs of the ſurface too is very eſſential. As the ſeed is ſo ſmall, and the plants, on their firſt coming up, ſo exceedingly tender, the buſh-harrow ſhould always be uſed after thoſe which are commonly employed. By this means a greater number are likely to vegetate, and their roots being better protected are leſs liable to injury.

Poppies (and when I uſe this name, I mean that particular kind before ſpecified) may be cultivated both by the drill and broad-caſt mode of huſbandry; at the ſame time it muſt be remembered, that the land for each requires a different diſpoſition. In the former this is not ſo material, the ſowing-machine regulating the diſtances of the rows according to the will of the operator; theſe ought to be nine inches or a foot aſunder, and in beds containing four rows, allowing a foot and a half between each. But, with reſpect to the latter, this point muſt be ſtrictly attended to: the ridges ſhould never exceed four feet in breadth; ſo that the

the furrows will anſwer the double purpoſe of preſerving the land throughout the winter, and, in the ſeaſon for collecting the Opium, ſerve as paths for the workmen.

Beſides two chances of a crop, I am decidedly in favour of autumnal ſowing; and the firſt week in September ſeems to be the moſt favourable period for this purpoſe. If the weather continues open, they will make ſuch a progreſs as to be capable of reſiſting the ſeverity of an inclement winter, without on the other hand being too forward; a circumſtance highly dangerous, as the firſt ſevere froſt is inevitably deſtructive.

On this account, whether by the drill or otherwiſe, a large proportion of ſeed ſhould be ſown at this ſeaſon, for the plants will defend each other; and as all the plants will not be equally forward, ſo, let the winter prove as it may, provided the ſeed has vegetated freely, there will be great probability of a good appearance in ſpring. If unfortunately, however, ſuch a winter as the laſt ſhould again occur, and the whole plantation fail, a circumſtance which has happened to myſelf, the ſpring ſowing ought not to be deferred longer than the firſt week in March.

I do not, without ſufficient reaſon, recommend that this operation ſhould be performed in autumn. The Poppies are not only generally larger, but even, when this is not the caſe, I know from experience, that they will yield a much larger proportion of Opium: for it ſeldom happens that a ſpring Poppy will bleed, as we term it, more than twice, while the others will bear ſcarifying till they are nearly ripe. This I imagine can only ariſe from the length of time the one has been in the ground in compariſon with the other. Indeed,

the difference is so ſtriking, that if the preſent winter deſtroys my plants, I ſhall be almoſt tempted to diſpoſe of my ſpring-ſowing to other purpoſes. In drilling, the neceſſity of covering the ſeed by harrowing is ſuſpended by the operation of the machine; and, in the broad-caſt method, a ſhower of rain will have all the effect without further trouble or expence.

Excepting great additional care, turnip and poppy hoeing are ſimilar, and in every reſpect may be conducted in the ſame manner. I believe the turnips are rather benefited, they certainly are not injured by being ſhaken, and will recover from the effects of a wound; but if the Poppies are accidentally touched, they will either exhauſt themſelves by bleeding, or dwindle ſo as to be of no value. But it is high time to proceed to the laſt point I propoſed to conſider, namely, the production and preparation of Opium.

In ordinary ſeaſons, the heads or capſules of the autumnal Poppies will be large enough for our purpoſe in the month of June; for at this time they will have attained about half their growth, or be equal in ſize to a ſmall tea-cup. I have invented a variety of inſtruments as ſcarificators; but as only two kinds were actually uſed, I am unwilling to trouble the Society with a deſcription of any other *.

Seven

* *Mr. Jones has ſince added the following Deſcription of the Inſtruments, and their mode of application. They remain in the Society's Repoſitory.*

The firſt of theſe inſtruments conſiſts of two thin ſteel blades fixed by a wedge in a wooden handle, ſo as to make inciſions about one-fourth of an inch from each other.

The other is made entirely of ſteel, and reſembles in form the tuning-fork of a harpſichord. It conſiſts of four bars, proceeding from a handle of a convenient length, a quarter of an inch

Seven, and ſometimes eight boys were employed from eight to twelve years of age, together with a man as a ſuperintendant. The children's book, which accompanies the inſtruments, contains only an account of ſix, as the eldeſt, being the ſon of my gardener, is included in another book. To the youngeſt I gave three-pence per day, and, if tractable and well diſpoſed, an additional penny for every additional year.

The ſteel inſtrument was uſed by the latter, and the others by the former. I have great reaſon to be ſatisfied with their conſtruction; for, notwithſtanding their ſimplicity, they proved themſelves fully equal to my purpoſe; and ſo conſiderable a trial has not ſuggeſted any other improvement, than that in the largeſt the two inner bars only ſhould be elaſtic; for the continual preſſure of the finger and thumb on the two outer ones, which is abſolutely neceſſary for the others to act, would be avoided, and conſequently much fatigue and inconvenience prevented.

It is of very little conſequence whether the firſt inciſions are made horizontally or vertically, with this inſtrument; for however luxuriantly the milk

inch wide, and two and a half long, each terminating with a bolſter, through which a ſcrew paſſes that fixes the ſcarificators. The centre bars ſhould be ſo elaſtic as to yield to the curvature of the capſule, upon the outer ones being preſſed by the finger and thumb; and by this means four inciſions are made at once, at equal diſtances. This inſtrument is an inch and three quarters in width; but, from the two outer blades, only an inch and a quarter. The bolſters are a quarter of an inch in diameter, and the ſcarificators a proportionate length, namely, three eighths. The wedge in the former, and a longitudinal aperture in the ſcarificators, or blades, of the latter, will regulate the depth of the inciſions, at the will of the operator. It is of the utmoſt importance that theſe ſhould not be made through the inner coat of the capſules.

may

may flow, by making four at one time, it ſo divides the ſtream that ſeldom any eſcapes. With the ſmaller ones we moſt commonly made them horizontally, beginning as near the top of the head as poſſible, and for this reaſon—all the juices, if the firſt inciſion was made at the bottom, would be naturally attracted by the aperture, and render every other completely fruitleſs, beſides occaſioning the certain loſs of a conſiderable quantity, by falling on the ſurrounding leaves; whereas, on the other hand, a proportion of milk will exude from each, and the Opium be equally diſtributed over the whole ſurface of the head.

No particular directions ſeem neceſſary for repeating this operation, any farther than that each time it ſhould be performed in a contrary direction, and continued till no more will exude, at intervals of four or five days or more, according to circumſtances: for, as the weather proves rainy or fair, they will be ſhorter or longer, the heads being ſooner repleniſhed in the one than the other.

Each of the children being provided with a tin cup, having one handle, ſo contrived as to fix itſelf to a girdle faſtened round his waiſt, with a common gardening knife they ſcraped off the Opium that appeared upon the heads in a ſoft aſh-coloured ſubſtance. Dewy mornings are beſt calculated for this purpoſe, and it ſhould be diſcontinued ſo ſoon as the ſun has gained a ſufficient power to diſſipate it; for, if perſevered in throughout the day, ſome of the Opium will recede into the interſtices, and more, in defiance of every endeavour, will remain upon the heads. The principal quantity exudes in the courſe of the night, and, uniting with the dew, it is taken off as readily and completely as with a ſponge.

6 Several

Several regulations were adopted to excite, as much as poſſible, a ſpirit of emulation. The name of each boy was written upon his cup, ſo as to aſcertain, on their return from collecting, who had been the moſt active. And although, in conſequence of the unſettled ſtate of the weather, this part of our proceſs continued ſo long as from the 6th of July to the ſecond week in September incluſive, the good effects were felt to the laſt. And, as for the reaſon already mentioned, an hour in the morning became ſo invaluable, thoſe who appeared in the ground at five o'clock, at the moſt buſy period, became entitled to an additional penny to their daily pay. This meaſure ſucceeded at firſt only with a few ; but the remainder, overcome by ſhame, at length attended equally well. In addition to this encouragement, I am under an engagement (in caſe I ſucceed with the Society), to ſuch whoſe behaviour has been uniformly good, to celebrate the circumſtance by a public dinner.

The interval from breakfaſt time to ſun-ſet, if the weather aſſumed a ſettled appearance, was occupied by ſcarifying. And here I again felt the good effects of ſtimulating meaſures : certain places were allotted to particular children, according to their ability, ſo as to diſcover who ſcarified the moſt and the beſt ; the ſuperintendant occaſionally following all of them, to obſerve whether any work was left unfiniſhed, and, if there were any, to complete it. If, in our progreſs, any one proved refractory, which happened in more inſtances than one, rather than have recourſe to ſeverity, and for the ſake of example, he was immediately diſcharged. I had numerous applications, and the firſt on the liſt always had the preference as his ſucceſſor.

Upon

Upon the whole, confidering it was the firft attempt of the kind, every thing proceeded very regularly; and had the fummer been propitious, notwithftanding my former difappointments, I fhould have had great caufe for fatisfaction. The largeft quantity that my man, feven children, and myfelf, were able to procure in one morning, from five to nine o'clock, was one pound and a half: this happened when the dew was remarkably great, and fucceeded one of the warmeft days in the fummer.

From the experience I have had, the precarioufnefs of our climate appears to me the only obftacle to the production of Opium in this kingdom. It may be faid that the fame inconvenience attends every other agricultural purfuit; and that hay, and a variety of productions, particularly hops, are much prejudiced from the fame caufe. I allow that they are fo; but the evil produced by a fudden alteration in this cafe is irreparable; for, fhould it happen after a fine fcarifying day, we do not only lofe the labour of that day, but all its produce. It becomes obvioufly neceffary, therefore, to be particularly circumfpect; and this is the only remedy we are able to procure. The Poppies will receive no damage from remaining entire; while, on the other hand, impatience may be injurious, if not deftructive.

As my notes furnifh me with no further particulars, I have very little more to add. The Opium, when firft collected, from its union with the dew, is much too foft to be fo formed as the Society will receive it.

To reduce it to a proper confiftence, taking Nature for our guide, it fhould be thinly fpread in fhallow difhes, and expofed, under glaffes, to the

rays

rays of the ſun. My opinion is, that Turkey Opium ſuffers conſiderably from the operation of fire; certain it is, that, with reſpect to its effluvia, it undergoes a complete alteration. I have covered it with its own leaves, thinking this a very convenient mode of package, and conceiving it to be important, in every new undertaking, by ſtudying appearances, to yield to the general prejudices which naturally prevail in favour of the article to which we have been accuſtomed.

The following teſtimony of the quality of the Opium is extracted from a letter from Dr. Woodville to Mr. Jones.

I have examined the Opium collected by you from the capſules of the White Poppy; and I have no doubt, from its taſte, ſmell, colour, and purity, but that it is more powerful and efficacious than the beſt foreign Opium imported into this country.

The late Dr. Alſton, when Profeſſor of Botany and the Materia Medica in the Univerſity of Edinburgh, informed the public more than ſixty years ago (ſee Med. Eſſays, vol. V), that the milky juice, drawn by him from the heads of the White Poppy, ſoon acquired the conſiſtence of Opium, when its taſte, ſmell, faculties, &c. were the ſame as thoſe of that drug.

In the year 1791 I convinced myſelf of the truth of his aſſertion, by repeating his experiments, which I noticed the following year in my Medical Botany. Soon after this time I appropriated a part of the garden at the Small-pox Hoſpital for the growth of the Papaver Somniferum, from the green capſules of which were collected between two and three ounces of Opium, which was found to be more efficacious than that of the exotic, as appeared upon trials of it made by ſeveral of my

medical friends. But the great trouble and length of time required for the collection of the juice induced me at that time to think, that the manufacture of this valuable medicine in England did not hold forth any profpect of commercial advantage. However, fince I have feen the great quantity of it collected under your direction, I fincerely hope that the above opinion will prove to be unfounded, and congratulate you on your fuccefs.

Other letters accompany this account from Doctor Pearfon, Mr. John Horner, and Mr. G. E. Lawrence, which prove the quality to be equal to the beft foreign Opium.

The Committee of Chemiftry, to whofe examination the Englifh Opium, prepared by Mr. Jones, was referred by the Society, ordered famples of the Opium to be left with feveral eminent chemifts for their analyfis and judgment; in confequence of which, the following preparations were laid before the Committee by thofe Gentlemen, *viz.*

Extract of Englifh Opium in proof fpirit.

Hard Extract of Englifh Opium.

Watery extract of Englifh Opium of the late Defpenfary.

Tincture of Englifh Opium of the prefent Pharmacopœia.

Tincture of Englifh Opium of the late Difpenfatory.

Englifh Opium powdered.

Similar preparations of fine foreign Opium were produced in comparifon.

From the general refult of thefe experiments it appears, that Mr. Jones's Englifh Opium is equal in quality to fine foreign Opium; and the certainty of its growth in this country, preparation, and efficacy, fairly eftablifhed.

L.

L. *On the Improvement of Time-keepers.* By DAVID RITTENHOUSE, LL. D. *President of the Society.*

From the TRANSACTIONS of the AMERICAN PHILOSOPHICAL SOCIETY.

WITH A PLATE.

THE invention and construction of time-keepers may be reckoned among the most successful exertions of human genius. Pendulum clocks especially have been made to measure time with astonishing accuracy; and if there are still some causes of inequality in their motions, the united efforts of mechanism, philosophy, and mathematics, will probably in time remove them.

The last and least of those causes, which perhaps may be worthy of notice when all others of more importance are removed, is that rising from unequal density of the air, which by varying the actual weight of the pendulum will accelerate or retard its motion. The effects arising from this cause will indeed be found very small, for if we suppose the greatest range of the barometer to be three inches, which indicates a change of density in the air of above one tenth of the whole; and supposing lead, of which pendulums are generally made, to be 8,800 times heavier than air, the variations of the actual weight of a pendulum may be one-88000 part of its whole weight, and consequently the change in its rate of going one-176000th part. And, as there are 86,400 seconds in a day, the clock may vary in its rate of

 going,

going, from this cauſe, about ½ a ſecond in 24 hours. Mentioning the barometer ſeems naturally to point out a remedy for this cauſe of irregularity by means of that inſtrument. But my deſign is at preſent to deſcribe a very different and extremely ſimple method, which, though only a matter of curioſity at preſent, may at ſome future time perhaps be found uſeful; eſpecially as the variation above-mentioned is governed ſolely by the actual denſity of the ſurrounding air, and the barometer can only give the weight of an entire column, which does not ſtrictly correſpond with the denſity of its baſe; whereas the method I propoſe depends on the real denſity of the air ſurrounding the pendulum; and nothing elſe.

Let AB (Plate XVI. Fig. 1.) be a pendulum vibrating on the point A, and removed from the perpendicular line DE. Let the inflexible rod be continued from BA to C, and let a body C, of equal dimenſions with the pendulum B, but hollow and light as poſſible, be fixed on the rod, making AC equal to AB. Now it is evident that B will be preſſed upwards by a force equal to the weight of its bulk in air, and its deſcent retarded. But the body C, will be equally preſſed upwards, and conſequently the motion of the pendulum towards the perpendicular will be as much accelerated. Theſe two forces therefore will deſtroy each other, and the pendulum will perform its vibrations in equal times, whether the air be light or heavy, denſe or rare.

I have for greater perſpicuity deſcribed the moſt ſimple caſe, but perhaps not the moſt eligible, for if we can enlarge the veſſel or body C, in any proportion, the diſtance of its centre from A may be diminiſhed at the ſame rate.

However

However plauſible the above may appear in theory, no doubt difficulties will occur when we attempt to reduce it into practice. But I am perſuaded they will not be found inſuperable.

The only experiment I have hitherto made on this ſubject has been merely to ſhew that a pendulum can be made in this manner which ſhall vibrate quicker in a denſe medium than in one more rare, contrary to what takes place with common pendulums.

I made a compound pendulum on the principles above-mentioned, of about one foot in its whole length. This pendulum, on many trials, made in the air 57 vibrations in a minute. On immerſing the whole in water it made 59 vibrations in the ſame time, ſhewing evidently that its motion was quicker in ſo denſe a medium as water than in the air. When the lower bob or pendulum only was plunged in water it made no more than 44 vibrations in a minute; the remaining 15 being ſolely the effect of the preſſure of the water againſt the upper veſſel C.

LI. *On the Expanſion of Wood by Heat. By the Author of the preceding Paper.*

From the TRANSACTIONS of the AMERICAN PHILOSOPHICAL SOCIETY.

IN the preſent ſtate of experimental philoſophy it is well known that bodies in general enlarge their dimenſions, or expand, on being heated, and contract

tract in cooling. From some experiments heretofore made, wood has been thought to make an exception to the general rule, and this opinion has so prevailed that many curious persons have applied wooden pendulum rods to their time-pieces, to prevent the variation in their rate of going, arising from the expansion and contracting of a metal rod. From my own observations, however, as well as those of some of my friends, the wooden pendulum rod does not appear to answer the expectations formed on it. I had in my possession for several years an excellent time-piece made for this society by an ingenious workman and worthy member of the society. The result of my constant attention to this clock was, that though its regular variations with heat and cold were probably much less than those of metal pendulums, it nevertheless went always faster in winter than in summer, and was liable to very sudden and considerable variations; arising, no doubt, from the combined effects of heat and cold, moisture and dryness. This determined me to make some careful experiments with a pyrometer capable of receiving a piece of wood of the length of a second pendulum. Several years ago I made some experiments of this kind, perfectly corresponding with those I have lately made, and which I now communicate to the society.

I took a straight grained piece of white hiccory, green, for I could not procure any seasoned, its length 39 inches, and about $\frac{3}{8}$ of an inch square. This I placed in my pyrometer, and kept it fully extended by a weight fastened to a string, going over a pulley. To the pyrometer I applied the tube and glasses of a good compounded microscope, and a micrometer, the value of the smaller

divisions

divisions whereof I found to be nearly .00053 parts of an inch, each.

The rod of wood being placed in the pyrometer, I poured sand all around it, heated to about 250 of Fahrenheit, which degree of heat I found the wood would bear without scorching. On pouring in the hot sand, the rod expanded very much, but soon began to contract, even before the sand was sensibly cooled, which I suppose arose from the hot sand extracting the moisture of the wood. It continued to contract as the whole grew cool, so that when the rod had acquired its first temperature it was near 30 of the above divisions shorter than at first. I repeated the operation a second and third time, and had then reason to conclude that the wood was nearly as dry as it would become by lying long in a dry air. I now let it cool to the temperature of the atmosphere which was 75° and heating the sand to 200 only, I poured it around the rod. In a few minutes it expanded 16 divisions. In half an hour the sand had cooled to 125, and the rod had contracted 11 divisions. In an hour more the sand was 80, and the rod shortened full 4 divisions more, being nearly equal to its length when the sand was first applied. On the whole I conclude that very dry wood expands with heat pretty regularly, though certainly in a much less degree than any of the metals or even glass.

The rod above mentioned having been kept in a dry place for twelve months, I again tried it with the pyrometer, having fixed near one end of it a small graduated scale of ivory, 360 divisions whereof were equal to one inch. This scale was viewed with the microscope, furnished with a cross hair, and I thought this method preferable to the screw micrometer used before.

The rod was placed in the pyrometer when the temperature of the air was about 60°. On pouring sand around it, heated a little higher than boiling water perhaps, it immediately expanded ½ a division, but in less than a minute it began to contract, and continued to do so for an hour, when I drew off the sand. It was now full 10 divisions shorter than at first, so that it had imbibed a great deal of moisture from the air which it again parted with to the heated sand. Three hours afterwards, when the rod was cool, I again poured the sand on it, heated as before. It now continued to expand for about three minutes, when its length was encreased 3¼ divisions, it then began to contract, and became full, 3 divisions shorter than when the sand was poured on it. I caused the sand to run off once more, and let the rod cool. Then heating the sand 250° by a thermometer, I poured it on the rod, and in a few minutes expanded 3¾ divisions, it then began to contract slowly, and in 15 minutes it became ⅔ of a division shorter than at first. On the whole, I concluded that the expansion of wood, in its length, will be irregular, corresponding partly to the warmth, and partly to the moisture of the atmosphere.

LII. *Deſcription of a new-invented Steam-Engine, intended to give Motion to Water-Wheels in Places where there is no Fall, and but a very ſmall Stream or Spring. By* JOHN NANCARROW.

From the TRANSACTIONS of the AMERICAN PHILOSOPHICAL SOCIETY.

WITH A PLATE.

A, (Plate XVI. Fig. 2,) the receiver, which may be made either of wood or iron.

B, B, B, B, B, wooden or caſt-iron pipes, for conveying the water to the receiver, and thence to the penſtock.

C, the penſtock or ciſtern.

D, the water-wheel.

E, the boiler, which may be either iron or copper.

F, the hot-well for ſupplying the boiler with water.

G, G, two ciſterns under the level of the water, in which the ſmall bores B, B, and the condenſer are contained.

H H H, the ſurface of the water with which the ſteam-engine and water-wheel are ſupplied.

a a, the ſteam-pipe, through which the ſteam is conveyed from the boiler to the receiver.

b, the feeding-pipe, for ſupplying the boiler with hot water.

c, *c*, *c*, *c*, *c*, the condenſing apparatus.

d, *d*, the pipe which conveys the hot water from the condenſer to the hot-well.

e, e, e, valves for admitting and excluding the water.

f f, the injection-pipe, and *g* the injection-cock.

h, the condenser.

It does not appear necessary to say any thing here on the manner in which this machine performs its operations without manual assistance, as the method of opening the cocks, by which the steam is admitted into the receiver and condensed, has been already well described by several writers. But it will be necessary to remark, that the receiver, penstock, and all the pipes, must be previously filled before any water can be delivered on the wheel; and when the steam in the boiler has acquired a sufficient strength, the valve at *c* is opened, and the steam immediately rushes from the boiler at E into the receiver A, the water descends through the tubes A and B, and ascends through the valve *e*, and the other pipe or tube B into the penstock C. This part of the operation being performed, and the valve *c* shut, that at *a* is suddenly opened, through which the steam rushes down the condensing-pipe *c*, and in its passage meets with a jet of cold water from the injection-cock *g*, by which it is condensed. A vacuum being made by this means in the receiver, the water is driven up to fill it a second time through the valves *e, e,* by the pressure of the external air, when the steam-valve at *c* is again opened, and the operation repeated for any length of time the machine is required to work.

There are many advantages which a steam-engine on this construction possesses beyond any thing of the kind hitherto invented; a few of which I shall beg leave to enumerate.

1. It

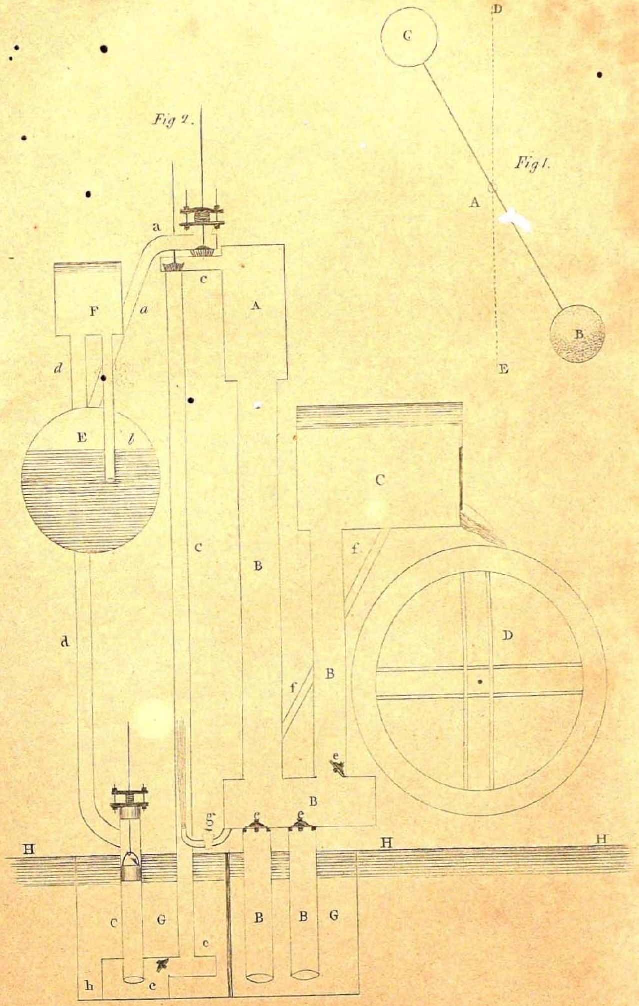


Fig 1.

Fig 2.

1. It is ſubject to little or no friction.

2. It may be erected at a ſmall expence when compared with any other ſort of ſteam-engine.

3. It has every advantage which may be attributed to Boulton and Watt's engines, by condenſing out of the receiver, either in the penſtock or at the level of the water.

4. Another very great advantage is, that the water in the upper part of the pipe adjoining the receiver, acquires a heat by its being in frequent contact with the ſteam, very nearly equal to that of boiling water; hence the receiver is always kept uniformly hot as in the caſe of Boulton and Watt's engines.

5. A very ſmall ſtream of water is ſufficient to ſupply this engine, (even where there is no fall,) for all the water raiſed by it is returned into the reſervoir H H H.

From the foregoing reaſons it manifeſtly appears, that no kind of ſteam-engine is ſo well adapted to give rotatory motion to machinery of every kind as this. Its form is ſimple, and the materials of which it is compoſed are cheap; the power is more than equal to any other machine of the kind, becauſe there is no deduction to be made for friction, except on account of turning the cocks, which is but trifling.

Its great utility is therefore evident in ſupplying water for every kind of work performed by a water-wheel, ſuch as griſt-mills, ſaw-mills, blaſt-furnaces, forges, &c.

LIII. *Of the Manufacture of Soap.*

(Continued from Page 286.)

Of the Troughs.

THE troughs, or veſſels into which the ſoap is poured after it has been boiled, are conſtructed in different ways, according to local circumſtances, or the judgement of the manufacturer. They are generally large ſtrong boxes, conſiſting of planks jointed together with wooden rivets. Theſe boxes are placed upon very ſtrong frames; in ſuch a manner, that the lye which runs from them may be collected into a reſervoir. Some of theſe troughs are large enough to contain two thouſand weight of ſoap; though ſome manufacturers prefer having them ſmaller, in which caſe they employ a larger number. The foremoſt plank of the troughs ſlides in a groove, ſo that it can be removed at pleaſure.

The troughs may alſo be made of ſtone ſlabs, with a ſliding plank in front.

In ſome manufactories, the troughs are conſtructed immediately below the ground floor of the work-ſhop. They are formed of ſmall ſtone ſlabs cemented with mortar, and lined with four planks, which are ſupported by ſmall ſtones; the front plank likewiſe ſlides in a groove, for the convenience of extracting the ſoap.

In general, the troughs ought to be placed in the ſame work-ſhop, where the ſoap is boiled; but if this cannot be done for want of room, they ought to be at leaſt as near to it as poſſible.

It

It is neceſſary alſo, before pouring the ſoap into the troughs, to ſtrew the bottom of each of them with a thin layer of powdered lime, which is to be made perfectly ſmooth with a beater. This precaution is neceſſary in order that the ſoap may not adhere to the troughs, and that it may be extracted with greater facility.

Of the different Utenſils requiſite in the Work-ſhop of the Soap Manufacturer.

The work-ſhop of the ſoap-manufacturer muſt be provided with different utenſils; ſuch as areometers, for determining the degrees of ſtrength of the lyes, trowels, ſhovels, iron mallets for breaking the maſſes of ſoda, iron mortars, rulers for dividing the ſoap, knives with very narrow blades for cutting it; and various other inſtruments, which the judicious artiſt will know how to diſpoſe in ſuch a manner as to facilitate and ſimplify his labour.

It is likewiſe evident that a well-regulated manufactory muſt be provided with an airy place, in which the maſſes of ſoap may be depoſited, after they have been taken out of the troughs, as they require to remain for ſome time expoſed to the air, in order that they may acquire the proper degree of hardneſs.

There muſt alſo be proper places for depoſiting the oil, the ſoda, and the ſoap that has been manufactured. All theſe arrangements muſt be made with judgement, and according to the local circumſtances of the buildings belonging to the manufactory.

Of the Method of preparing the Lyes.

Before proceeding to the lixiviation of the ſoda, it is proper to pulveriſe it; the firſt operation therefore is, to break it into pieces with an iron hammer, after which it is pounded in mortars of iron; but, in large manufactories, it is found more expeditious to bruiſe it upon a hard black ſtone, by means of a flat block of iron.

It is not reduced to a fine powder, it being ſufficient if it be reduced to a ſtate of tenuity, equal to that of large grains of ſand, or ſmall hazelnuts.

It is alſo neceſſary that we ſhould know the quantity of oil which is to be converted into ſoap, in order that we may be able to determine the reſpective quantities of ſoda and lime that are to be lixiviated. Thus, if we intend to prepare a thouſand pounds of ſoap, we may obſerve the following proportions.

Oil of Olives, - - - -	600
Good Soda, - - - - -	500
Quick-lime, - - - - -	100

Theſe quantities may be multiplied according as we wiſh to manufacture a larger quantity of ſoap.

The ſoda being pulveriſed, as above mentioned, we muſt moiſten the lime with a ſmall quantity of water, upon which, if it be good, it will immediately become heated and crumble into powder. It muſt then be paſſed through a ſieve, and mixed with the ſoda by means of a ſhovel. This mixture is next put into a tub, at the bottom of which ſome tile-ſherds are laid, in order to facilitate

litate the running of the lye; and upon the whole a certain quantity of water is poured, so as to soak the mixture well through, and cover it to the height of three or four finger-breadths. When the water has stood upon it for three or four hours, the faucet at the bottom of the tub is to be opened, and the liquid which runs out carefully collected. This liquid will be found to be of an acrid and caustic quality, and is called the *first lye*. A fresh egg ought not to sink in it; but its strength may be determined, with much greater certainty, by means of an areometer for salts. This first lye indicates, by the areometer, from 18 to 25 degrees. It ought to be kept in a separate vessel.

When the lye ceases to run, the faucet must be closed, and a fresh quantity of water poured upon the mixture. After a few hours the faucet is again opened, and a second lye runs out, weaker than the first, but which still indicates by the areometer from 10 to 15 degrees. This is the *second lye*, and must also be kept in a separate vessel. In this second lixiviation, the first portions of the liquid which runs out will be nearly as strong as the first lye, and may therefore be mixed with it.

Another fresh quantity of water is now poured into the bucking-tub, and a third lye is drawn off, much weaker than the two first, as it indicates only from 4 to 8 degrees by the areometer. This is termed the *third lye*, and kept in a separate vessel like the others.

Finally, in order to exhaust the soda of the whole of its alkali, a fresh quantity of water is poured upon it, and the weak lye which is drawn off, is put by, to be used in a new lixiviation.

The

The soda ought now to be found entirely exhausted of its alkali, and taken out of the tub. It is made use of as a manure for wet grounds, under the name of buck-ashes (*charrée*).

From what has been said, it appears that the areometer is an instrument that cannot be dispensed with, in the preparation of lyes.

Some manufacturers mix a larger proportion of lime with the soda, than that which we have laid down. Some, for example, mix it with the soda in the proportion of one to two; others, of one to three: But there are some also, who make use of a smaller proportion than ours, that which they employ being one part of lime to six of soda. We conceive, that when the lime is of good quality, the proportion of one fifth is sufficient to render the soda sufficiently caustic; but when the lime has been badly burnt, or when it is not sufficiently fresh, it may be used in a larger proportion, for an excess of lime can never injure the quality of the caustic lye. When the alkali has been deprived of its carbonic acid by means of a proportionate quantity of lime, the excess of the latter, which may have been introduced, does not augment its causticity; and the only harm that it can do in the lixiviation is, by increasing the quantity of materials to be lixiviated, and giving the mass a more pastey consistence; besides which, it cannot be procured without expence, and in the management of manufactories œconomy is always to be attended to.

Of the Boiling and Moulding of the Soap.

We have already observed that 600 lbs. of oil are requisite for the preparation of 1000 lbs. of

soap.

ſoap. We have alſo, in deſcribing the method of preparing the lyes, determined the quantities of ſoda and lime neceſſary for converting into ſoap 600 lbs. of oil; but, as the ſoap is only produced by a combination of the oil with the alkali contained in the lyes, it is neceſſary that theſe ſhould be already prepared, before we can proceed to the boiling of the ſoap.

When therefore the lixiviations have been completed, the oil is poured into the boiler (which we have already deſcribed). A portion of the third; that is, of the weakeſt lye, is then introduced, and a fire is kindled under the boiler. The mixture is ſtirred with a wooden trowel, in order to facilitate the combination of the oil with the alkaline lye. The heat of the fire ought to be ſufficiently ſtrong to make this liquor boil; and it is always kept at the ſame degree of temperature, by adding from time to time, and in ſeparate portions, the remainder of the third lye; when this has been conſumed, the ſecond lye is introduced into the boiler, in ſeparate portions like the former, the mixture being at the ſame time carefully ſtirred. The oil will at firſt become of a milky appearance, it will unite completely with the lye, and, after it has boiled for ſome time, we ſhall find it to have acquired a greater degree of conſiſtence. When this has taken place, a ſmall portion of the firſt lye is added, and the mixture carefully ſtirred as before. The fire ought to be kept up uniformly at the ſame degree, that is, ſo as to keep the mixture conſtantly boiling. The progreſſive addition of a part of the *firſt lye*, by ſmall quantities at a time, will give the mixture a far greater degree of conſiſtence, and when the fire has been kept up for ſome time longer, we ſhall

 find

find it to grow thicker and thicker, and ſeparate itſelf from the watery liquid. Some pounds of ſea-ſalt are now added to it, which will render the ſeparation much more complete, ſo that the ſaponaceous ſubſtance will preſent itſelf under the form of a granulated paſte. The boiling is ſtill continued for ſome hours, after which the fuel is withdrawn from the aſh-pit, and the mixture is no more ſtirred. In the ſpace of a few hours, the ſaponaceous ſubſtance will collect itſelf in the upper part of the boiler, and the liquid which will have ſeparated itſelf from the ſoap, and deſcended to the lower part of the boiler, may then be drawn off by the tube at the bottom of the veſſel. This liquor is opaque, not cauſtic like the alkaline lyes that have been employed, and it effervesces with acids. The manufacturers do not throw it away, but paſs it again over a mixture of lime and ſoda, and make uſe of it as a lye towards the end of a new boiling.

When the whole of the liquid which remained under the ſaponaceous paſte has been drawn off through the faucet at the bottom of the boiler, the fire is lighted again, and, in order to facilitate the liquefication of the ſoap, a ſmall quantity of water, or rather of weak lye, is added to it. When the mixture is perfectly liquefied and brought to the ſtate of ebullition, the remainder of the firſt lye is added to it by ſeparate portions. It is in this ſecond operation that the boiling of the ſoap is particularly to be attended to; for this purpoſe, a ſmall quantity is taken out from time to time, which is placed upon a piece of ſlate to cool, and by the degree of conſiſtence which the ſoap aſſumes, or by rubbing it between the fingers, when it

it has cooled, we judge whether it is properly boiled.

It is a useful precaution to keep always a small quantity of strong lye in reserve, in order to add it to the mass, in case we should find that the prescribed quantity is not sufficient for completely saponifying the oil. When the soap has been sufficiently boiled, it will acquire a good consistence by cooling, it will appear dry when rubbed between the fingers, and in the boiler it will assume the form of a greyish paste. The fire is then withdrawn from under the boiler, and the soap suffered to stand at rest for some hours; after which, the liquor, which will have collected below the soap, is drawn off by the faucet as above. The boiler is now heated again, and a small quantity of water added to the saponaceous paste, which will give it the proper degree of cohesion and consistence; which being obtained, the fire is withdrawn, and the soap suffered to remain in the boiler till it has become sufficiently cool to be poured into the moulds.

Whilst the soap is cooling in the boiler, the moulds are arranged, and a small quantity of powdered lime is spread as even as possible on the bottom of each. The soap is then laded out of the boiler, or sometimes drawn off by the faucet if its bore be sufficiently large, and without loss of time conveyed to, and poured into the moulds. For this operation buckets of copper or wood are employed. After two or three days in the winter season, or more in the summer, the soap will be sufficiently solid to be taken out of the moulds and divided into tables or cakes, of the form usually given to soap. This division is first marked out by means of a ruler, after which the soap is

cut, with a ſharp and narrow-bladed knife, into a number of blocks or ſquares, which are again ſubdivided into ſmaller by means of a braſs wire. It is then conveyed into the drying room, in order that it may acquire the requiſite degree of hardneſs; and it is fit for ſale as ſoon as it no longer yields to the preſſure of the fingers.

Should it happen that too much water had been added to the ſoap before drawing it out of the boiler, the manufacturer, who wiſhes to act honeſtly, ought to let it remain in the drying room till this ſuperfluous quantity of water has evaporated, in order that he may not introduce into commerce water inſtead of ſoap. This evaporation takes place in a ſhort time, provided the drying room be not ſituated in a moiſt place. The manufacturer is within the due bounds, if he makes not more than five pounds of ſoap with three pounds of oil; that is to ſay, a thouſand pounds of ſoap with ſix hundred pounds of oil: but he is reprehenſible if with one pound of oil he makes three pounds of ſoap, and even more. At preſent too much ſoap thus diluted with water is ſold at Paris.

The ſoap-manufacturers of Marſeilles do not exactly follow the proceſs which we have deſcribed in making their ſoap; each of them pretending to have a peculiar ſecret of his own, which he conceals with a great air of myſtery; but in general, their methods are reducible to two principal ones: the firſt conſiſts in preparing three kinds of lye, ſuch as we have deſcribed above, and employing theſe in different ways during the boiling of the ſoap; the other conſiſts in preparing lyes of different degrees of ſtrength, according to an

arithmetical progreſſion, from 4 degrees to 16 *. They begin by combining the oil with a certain quantity of lye at four degrees, and let this boil firſt, before they add the remainder of their lye of this degree; they then proceed in the ſame manner to the next following degree, which they gradually exhauſt; and thus progreſſively to their laſt degree, taking care alſo to augment gradually the quantity of lye, which they add in proportion as their mixture grows thicker. Thus they arrive at the lyes of 15 and 16 degrees; and then they pay great attention not to add this laſt lye in exceſs, for fear of their mixture loſing its coheſion, or *turning (tourner)* as they term it—an accident, which they conſider as one of the moſt embarraſſing that can occur, on account of the difficulty which they find in re-eſtabliſhing the coheſion of the paſte, which they endeavour conſtantly to preſerve and increaſe, and becauſe in this caſe they do not obtain ſo large a quantity of ſoap. They know their ſoap to be ſufficiently boiled by the ſame tokens we have already mentioned, and pour it into the moulds in the ſame manner as above deſcribed.

We prefer the method firſt deſcribed to the latter: it conſtantly affords ſoap of a good quality; and though it differs in ſome reſpects from that adopted by many manufacturers, we venture to affirm, that if the operator does not deviate from the rules we have laid down, he cannot fail to produce ſoap of very good quality.

* That means, the ſtrength of theſe lyes increaſes progreſſively, always by the ſame number of degrees, as in the following ſeries of numbers: 4, 6, 8, 10, 12, 14, 16; or, 4, 7, 10, 13, 16.

Citizen

Citizen Lartigue, the pupil of one * of our number, after having aſſiſted us in the various experiments of which we are about to give an account, performed according to this method ſeveral boilings of ſoap in the large way, which ſucceeded perfectly well.

Of Marbled Soap.

Marbled ſoap differs from the ordinary white ſoap only by the colouring ſubſtances which are added to it, in order to tinge it with blue and red ſtreaks or ſpots. The ſubſtances employed for this purpoſe are the black and red oxyds of iron. This ſoap is alſo harder than the white, as, in order to marble it, it becomes neceſſary to dry it more, or deprive it of more of the water mixed with it. The method of marbling it is by adding to it, after it has been boiled, and the alkaline lye drawn off from below it, a certain quantity of freſh lye, and ſhortly after a ſolution of ſulphate of iron †. The cauſtic ſoda decompoſes the ſulphate of iron, and the reſult is a precipitate or black oxyd of iron, which being enveloped in the ſaponaceous paſte, imparts to it a blue tinge. The ſoap is then ſuffered to cool a little in the boiler, after which the alkaline liquid collected at the bottom is drawn off by the faucet, and now the ſoap is heated only in order to liquefy it.

To produce the red colour, the red oxyde of iron is diluted and intimately mixed with a ſufficient quantity of water. A workman placed over

* Viz. Citizen Pelletier.

† Commonly termed *Green Copperas (couperoſe verte)*. It is a combination of ſulphuric acid *(oil of vitriol)* with oxyde of iron.

the boiler ſtirs the ſoap, whilſt another pours into it the red colouring liquid, and in order that this may mix in a uniform manner with the ſaponaceous paſte, the workman who ſtirs it takes care to make no other motion with his inſtrument than drawing it from bottom to top. The ſoap ought not to be liquid, but of the conſiſtence of a paſte, when the red colour is added to it, and as ſoon as this has been done it ought to be put into the moulds. This operation is ſomewhat more difficult with the marbled ſoap than with the white, the latter being more fluid at the time when it is put into the moulds.

Three pounds of olive-oil yield, as we have mentioned above, five pounds of white ſoap; but the ſame quantity of oil affords only about four pounds and a quarter of marbled ſoap. This is the reaſon why the latter kind is more ſolid than the former; and for the ſame reaſon alſo the waſherwomen prefer the marbled ſoap, there being a greater quantity of effective ſoap in a given weight of the marbled kind.

This ſoap is preferred for exportation into hot countries, on account of its hardneſs, and becauſe it does not liquefy in a high temperature. The ſame hardneſs might be imparted to the white ſoap by drying it more, which would give it all the eſſential properties of the marbled. It would therefore be very deſirable to know how to diſtinguiſh ſoaps, whoſe bulk is increaſed by the admixture of water, from thoſe which do not contain more than their due proportion, and particularly that the manufacturers might prepare ſoaps with as little admixture of water as poſſible, which then would be prefered to the marbled; for it is not the colouring matter, as may well be conceived, which

which improves the qualities of ſoap, but, on the contrary, this colouring matter, being a foreign ſubſtance introduced into the ſoap, removes it from that degree of perfection which we ought to endeavour to impart to it.

TO BE CONCLUDED IN OUR NEXT.

LIV. *Obſervations on the Pine Tree, and Inſtructions relative to the Manner of extracting the Tar, and other reſinous Principles from it.*

By M. CHAPTAL.

FROM THE *JOURNAL DES ARTS ET MANUFACTURES.*

THERE are few trees from the cultivation of which ſo many advantages are likely to reſult as that known by the name of the Pine.

It grows in dry and ſandy grounds, in the midſt of rocks; it crowns the ſummits of mountains with its agreeable verdure; it appropriates to itſelf ſoils which ſeems to be ſhunned by every other vegetable; it ſhoots up rapidly, requires ſcarcely any culture, and its uſes and products are as multifarious as they are uſeful.

The young plants and the ſhoots, lopped off from the trees of all ages, furniſh a large ſupply of props for the vines.

The wood of the Pine affords very good fuel; its flame is briſk, and is attended with no other inconvenience than that of producing too much ſmoke.

In

In all countries where the Pine abounds, thoſe pieces of its wood which contain the moſt reſin are uſed inſtead of candles.

The trunks of theſe trees are very proper for making planks: they are likewiſe employed for forming the bodies of pumps, for water-pipes, for beams, for the ſide planks of the decks of ſhips, for maſts, &c.

Its fruit is an alimentary ſubſtance of ſome conſequence: many domeſtic animals are very fond of feeding upon it.

Of the wood of the Pine a ſpecies of charcoal is made, which is found to be very uſeful in metallurgical operations.

Theſe trees, when arrived at a certain ſize, afford an annual crop of twelve or fifteen pounds of reſin.

The trees which fall down with age, and thoſe which are torn out of the ground, or broken off from their roots by the wind, as alſo the chips cut from the trunks when they are made into beams, the roots, &c. affotd ſtill a large quantity of tar.

Proprietors of lands cannot therefore be too ſtrongly urged to cultivate ſo valuable a tree.

It would require nothing more than to ſcatter the fruit on ſuch lands as are adapted to the nature of the tree, in order to enſure its production.

We muſt take care not to ſow the pine-fruit in any other ſpots than ſuch as are ſheltered from the rays of the ſun; for expoſure to the ſun proves deſtructive to the young plants. On this account the trees in the pine-foreſts are not filled in a regular manner, but only here and there, in order to enſure an uninterrupted re-production.

But this tree is not only not so abundant as it ought to be, but in many departments of the Republic, where it is very plentiful, the inhabitants neglect to avail themselves of the advantages they might draw from its resinous particles.

It is, therefore, necessary, in every point of view, to direct the attention of the husbandman to the culture of the Pine. He ought to be taught, that his own interest is connected with the public good; and that whilst he furnishes our manufactories and arsenals with the resin required for the operations which are there carried on, he at the same time puts himself in possession of a new branch of industry, a new source of gain.

All that we aim at, at present, is to make known the simple process, by which the various principles contained in the Pine are to be extracted and prepared.

Processes for extracting the resinous Principles of the Pine.

All pines yield a resinous juice, but some in larger quanties than others.

Those which contain the greatest quantity of resin are the Cyprus Pine, the Grey, the White, and the Red Pines.

Soil, age, and size, have less influence upon the quantity of resin than the exposure of the plant, and the thickness of the bark: the Pines exposed to the south, and to the rays of the sun, yield it in large quantities, whilst those whose bark is very thick yield less. Pines that grow too near to each other contain scarcely any resin; the interval between them ought to be twelve feet.

feet. The diſtance ought to be determined by the ſituation of the ground, and the poſition of the trees with reſpect to expoſure to the ſun. The young branches that ſhoot out from the ſtem ſhould be carefully lopped off, by which means the tree grows to a greater height, and its trunk is more expoſed to the action of the ſun.

Pines become more reſinous in rich grounds, and in rainy ſeaſons; but then the reſin is not equally good.

Young Pines yield reſin as well as the old ones, but the extraction of it enfeebles them.

The reſin flows particularly during the ſummer ſeaſon.

Pines yield reſin during the ſpace of twenty or twenty-five years, and the extraction of it is generally commenced when they are twenty years old.

The reſinous juice flows out almoſt ſolely from the woody part of the tree, and runs down between the wood and the bark; the exterior layers yield it in greater quantity than the interior ones; only a few drops of good reſin tranſude through the bark. The roots alſo yield a great quantity of juice. The knots contain more reſin than the reſt of the tree, the roots more than the branches, &c.; and the woody part in the vicinity of notches or wounds of the ſtem yields ſtill more.

When the Pines have arrived at the age of about twenty years, they have acquired a circumference of three or four feet, and are ſufficiently ſtrong to admit of the extraction of a part of the reſinous juice which circulates in the different parts of the tree.

The reſinous juice begins to flow in the ſpring, and it is during this ſeaſon that inciſions are

begun to be made into the trees, in order to extract their produce.

The juice continues to flow till the autumn. It generally begins to flow during the month of May, and ceaſes in September.

In order to facilitate this flow, and determine it to a ſingle point, a ſpace, three inches in breadth, and ſix or eight in length, is pitched upon at the foot of the trunk, quite near to the earth, on the ſide expoſed to the ſouth, and in a part which appears to abound moſt in reſin, and to be moſt diſpoſed to let it run off: in this place the bark is peeled off, and a chip cut out of the wood, from whence the reſin immediately begins to flow, and is ſeen tranſuding through the ligneous fibres, in ſmall tranſparent drops; it runs down upon the bark of the lower part of the trunk, and is received into a hole made at the root of the tree, or into a veſſel placed there for that purpoſe.

When the flow of the reſin begins to grow languid, the wound of the tree is enlarged at its upper part, and a new layer of the woody part is cut off. The wound muſt be renewed in this manner once every fortnight.

Thus the wound is progreſſively enlarged, and at the end of the year it is a foot in length. The operation is diſcontinued as ſoon as the return of the froſt hardens the reſin, and ſtops its flow.

In the following ſpring, the wound is again renewed, and at the end of five or ſix years it has acquired a height of five or ſix feet.

When it has been enlarged to this height, a new cut is made at the foot of the trunk, almoſt cloſe to the former, and is gradually carried higher up, parallel with the firſt.

Whilst the resin is discharged by this second wound, the first heals up in such a manner, that the operation may be successively performed round the whole circumference of the tree, and repeated upon the places where the former wounds had been made.

In renewing the wounds, we must use the precautions, to cut the chips very thin. For this purpose, the workman must be provided with very sharp instruments. Upon these precautions the health of the tree, and the quantity of resin produced, materially depends.

In this manner a single person may manage from two thousand five hundred to two thousand eight hundred feet of trees. He pours into barrels the resin collected in the vessels placed for receiving it at the foot of the trees, and it is then fit to be introduced into commerce.

The resin obtained in this manner in Guienne is known by the name of *galipot*; that of Provence is termed *Perinne vierge*. In some parts of Provence, it is the practice to make a small hole at the bottom of that which receives the resin, and to separate the one from the other, by laying some twigs of rosemary over the orifice of the second. By this means the more fluid part of the resin filtrates into the smaller hole, and the resin obtained in this manner is termed *bijon*.

A healthy tree yields annually from twelve to fifteen pounds of resin.

From the autumn to the spring, the small quantity of resin which flows from the tree hardens upon the surface, from which it is detached by means of iron scrapers fixed to the end of a pole. This resin is known at Bourdeaux by the name of *barras*.

In

In order to form the yellow ſpecies of reſin, known in commerce by the name of *brai ſec*, and in Provence by that of *raſe*, they place upon a ſtove a copper boiler, the ſides of which are bent into a lip, ſeveral inches in breadth, which is provided, at ſome point of its circumference, with a gutter, ſix or eight inches in length, under which is placed a trough hollowed into a piece of a pine-trunk, and filled with water.

Both the liquid and the ſolid reſin that has been obtained from the Pine is put into the boiler. This ſubſtance is melted by a moderate heat: as ſoon as it is melted, a quantity of water is poured upon it, upon which the reſin puffs up, and a part of it runs into the trough, which the workman continually pours back into the boiler, mixing the whole maſs well together; and this manœuvre he continues till the whole of the water is diſſipated. Towards the end of the operation, the melted reſin becomes more tranquil, and acquires a yellow colour, in which ſtate it is poured into another trough, where it filtrates through ſtraw, and runs thence into moulds carefully formed in the ſand.

Theſe moulds are round holes, the ſides of which are rendered compact by being well beaten. The cakes of reſin, which aſſume the ſhape of theſe moulds, weigh about two hundred pounds.

If, inſtead of boiling the reſin in an open veſſel, we boil it in an alembic with water, it forms a ſpecies of oil of turpentine, termed *eau de roſe*, which, however, is greatly inferior to the genuine oil of turpentine.

When the *galipot* is put into troughs compoſed of ſeveral planks faſtened together, and expoſed to

to the ſun, the part which oozes through the crevices is known by the name of *Sun Turpentine (térébenthine de ſoleil).*

The term of *turpentine of the boiler (térébenthine de chaudriére)* is applied to the *galipot* that has been melted in one of theſe veſſels.

Even the moſt liquid *galipot* has been claſſed amongſt the turpentines; but this ſpecies is the worſt of all in its qualities, being inferior to that of the larch, and ſtill more ſo to that of the fir.

The living tree does not give out the whole of its reſin by the wounds made in its trunk; but after it is dead, it is ſubjected to an operation, by which every particle is extracted; and it is this reſinous ſubſtance, extracted from the dead tree, that is known by the name of *tar (goudron).*

In order to extract the tar, all that is required is, to apply to thoſe parts of the wood in which it is contained, a degree of heat ſufficient to ſoften it, and make it run, without either ſetting fire to, or volatilizing it.

This end is obtained by diſpoſing the wood of the Pine, previouſly cut into ſmall pieces, in a heap, the ſides of which are covered with earth, ſods, or bricks. The whole maſs is heated by means of fire applied to the upper part, and all the reſin that runs down to the bottom is carried off from the heap by gutters.

The kilns, in which this ſmothered combuſtion is performed, are of different forms and dimenſions. But all the proceſſes which have hitherto been made known have certain principles and operations in common with each other, of which we ſhall give ſome account.

For extracting tar, the heart of the tree, the knots, and all the reſinous veins, are choſen.

The

The red parts of the wood are taken in preference to the reſt.

The bark and leaves are rejected, as the tar which they furniſh is of an inferior quality.

The tar is extracted alſo from the ſtraw, which has ſerved for filtrating the *brai ſec*, and from the chips that have been cut off from the trunk, in order to renew the wounds of the tree.

In preparing tar, uſe is alſo made of trees exhauſted of their reſin, and particularly of thoſe decayed by age, of thoſe that have been broken off, or rooted up by the wind, and of the chips produced in various ſpecies of labour for which this wood is employed.

The tar is the better in proportion as the trees from which it is extracted are more reſinous, the more attention is paid to the ſeparation of the bark and young ſhoots, and the more care is taken to prevent the combuſtion and volatiliſation of the reſin.

In order to obtain good tar, it is alſo of eſſential advantage to employ wood that is neither too green nor too dry; that which is in a ſtate of half-dryneſs is the beſt.

The trees may be felled at any ſeaſon of the year, but it is principally during the autumn that they are hewn down for this purpoſe, and the extraction of the tar is performed during the winter.

It is farther neceſſary that the wood ſhould be cut into ſmall pieces, as equal as poſſible in ſize, in order that the whole of the reſin which it contains may be melted out at one and the ſame time.

The management of the fire demands likewiſe great attention; for, 1, too active a fire burns and

and dissipates the resin; 2, too violent a heat volatilises it, and produces tar of too dry a nature; and, 3, if the heat be too low, it extracts only a part of the resin, and leaves combined with the tar the watery particles which existed in the vegetable.

A kiln, filled with very red and resinous wood, yields a quarter of its weight of tar; but this substance is generally obtained in the proportion of not more than 10 or 12 *per cent.* to the whole.

Each species of kiln that has been employed for the extraction of tar appears to me to possess certain advantages and disadvantages of its own.

In the mountains of Provence, the kilns are shaped like large pitchers, partly sunk into the ground; they are eighteen inches in diameter at the bottom, six feet in the belly, and two at the top.

The wood is cut into pieces eighteen inches long, and an inch and a half wide; these are disposed in layers of the form of a gridiron, having the interstices filled up by other pieces placed perpendicularly.

In the neighbourhood of Bourdeaux they dig a circular pit, thirty-six or forty feet in circumference, where a hearth is formed by bricks placed upon the ground, and well cemented together. A small canal is made at the centre for receiving the tar, and conveying it into a receptacle, which is termed the *vault (cave)*, and in which a quantity of water is kept, in order to purify the tar. The vault is emptied as fast as it fills, and the tar put into the barrels, in which it is transported from place to place. The hearth of the kiln is covered with wood cut into small pieces, and piled into a heap eight or

 ten

ten feet high. The sides of the heaps are covered with sods, and clods of earth; and the upper part of the cone, where they place a layer of wood drier than the rest, is set on fire. The heat communicates itself to the whole mass, and when the fire slackens, openings are made to increase the draught, by taking out some of the clods in different parts of the sides.

When the operation is completed, all the draught-holes are closed, and the charcoal that has been formed is taken out of the kiln.

The kilns used in *Louisiana* differ very little from those which we have just described; only the ground is not covered with bricks, but the tar is made to run merely by the slope of the earth, which is strongly beaten, and thence it is conveyed, by very long gutters, into reservoirs dug into the ground.

The method used in the *Valais*, for extracting the tar, is practised by all the peasants; and as it presents to us all the means proper to be employed for avoiding any waste of the tar, and obtaining it of good quality, we shall describe it with more minuteness than the others, introducing at the same time some variations, which, from our observations and experience, appear to us to be necessary.

A kiln is constructed of a form similar to that of an egg placed upon one end. Its dimensions may be varied according to the quantity of wood we have to burn: it ought, in general, to be twice as high as it is broad. The largest may be ten feet in height, five in diameter, and two and a half at the superior orifice.

In constructing this kiln, the first operation is the marking out of its dimensions at the base, after

after which the walls are raifed of ftone, to the height of two-thirds of the whole height of the kiln. The infide is paved with free-ftone, well joined together; or, where this cannot be procured, with bricks laid upon the ground, and well cemented. The bottom is concave, and of the form of an egg-fhell. Six inches from the bottom an orifice is made, eighteen lines in diameter, which terminates on the outfide and at the bottom of the kiln, floping down fix or eight inches, and to this is adapted a large iron tube, refembling a mufket-barrel, of a large-bore, for the purpofe of conveying the tar into the barrels deftined to receive it.

At the diftance of twenty or twenty-five inches from the bottom of the kiln, bars of iron are placed, parallel with each other, for fupporting the wood, and letting the tar, which is melted out by the heat, run down to the bottom.

The conftruction of the kiln is completed with fragments of ftone and earth, and at the top an open fpace is left, two feet and a half in diameter, for the convenience of filling the kiln.

It is carefully plaiftered over both within and without, and any cracks or flaws that may be formed are immediately ftopped up.

It is alfo of advantage to make fome perforations in the walls of the kiln, which may be ufed, as occafion requires, for increafing the draught, and graduating the heat at pleafure.

When a kiln of this kind has been conftructed, a man goes into the infide, and difpofes the wood, cut into billets two inches broad and eighteen long, upon the grate, and with thefe he fills up the whole cavity, taking great care to leave no empty fpaces, and the top of the kiln he fills with dry chips.

 The

The orifice at the top is cloſed up with flat ſtones, or plates of iron or copper, ſo as to leave only one opening, or chimney, about four inches in diameter.

The chips are then ſet on fire, and, when the fire is well kindled, this orifice is cloſed with a flat ſtone, which is covered over with earth. The melting now commences, and the tar runs down to the bottom, whence it is conveyed, by the tube inſerted there, into the barrel.

If the melting ſhould ceaſe, the orifice muſt be opened again, and even a draught of air let in through the holes in the ſides of the kiln.

If the ſmoke finds a vent through the ſides of the building, the holes muſt be ſtopped with wet earth, ſods, or other ſubſtances.

When the kiln has cooled, it is opened, and the charcoal produced by the operation is taken out. The impurities collected at the bottom are then extracted, and the kiln is filled again.

By a kiln of this conſtruction, which is neither laborious, expenſive, nor difficult, all unneceſſary waſte is avoided; and the tar muſt neceſſarily be more pure, as, on account of the ſolidity of the ſtructure, the materials cannot be mixed with it, beſides that the tar preſerves all thoſe principles which the other furnaces ſuffer to be diſſipated.

The expence which attends the conſtruction of ſuch a furnace cannot be placed in competition with the advantages which it affords. Beſides, it is built in the midſt of the foreſts, and conſequently ſurrounded with all the materials that are required. Moreover, it is a ſtable and permanent eſtabliſhment, whilſt the others one is obliged to demoliſh and rebuild for every ſingle operation.

If

If we employ the precautions here laid down, in the preparation of our tar, it will be found ſcarcely, if at all, inferior in its qualities to that obtained from the North.

Another reſinous preparation, known in commerce by the name of *brai-gras*, is obtained by filling the kiln with alternate layers of green wood and reſin, or dry chips, making the uppermoſt layer of dry chips. The orifice by which the juice might run out is cloſed, and fire applied to the kiln.

Great care is taken to prevent the production of flame, and to produce a dead heat, which is kept up for ſeven or eight days. By this means, the reſin is melted, mixes with the ſap, and runs to the bottom of the kiln. When the operation is finiſhed, the orifice is uncloſed, and the *brai-gras* runs out.

Sometimes the tar which is obtained from very reſinous wood is uſed inſtead of the *brai-gras*.

By mixing *brai-ſec* with very reſinous wood, and not opening the vent-hole till the reſinous ſubſtance has boiled, we obtain *brai-gras*.

In order to make *lamp-black*, ſmall pieces of the refuſe of all theſe reſinous ſubſtances are put into iron pots, and placed in the middle of a cloſe chamber, entirely lined with canvas or paper; after which, the pieces of reſin are ſet on fire. A thick ſmoke is thus produced, which ſettles upon the walls, and forms the ſubſtance termed lamp-black. The places choſen for performing this operation ought always to be in a perfectly inſulated ſituation. Lamp-black is uſed in painting, dying, printing, japanning, &c.

LV.

LV. *List of Patents for Inventions, &c.*

(Continued from Page 288.)

Thomas Parker, of Broomward, near Glafgow, in North Britain, Efquire, and William Telfer and Alexander Afleck, of Glafgow aforefaid, Mathematical Inftrument-makers; for their improvements in preparing and manufacturing of flax, hemp, filk, and other materials.

Dated February 3, 1801.

Robert Young, of the city of Bath, Somerfetfhire, Ironmonger; for an improved fire-ftove or grate. Dated February 3, 1801.

Edmund Cartwright, of St. Mary-le-Bone, Middlefex, Clerk, M. A.; for improvements in the framing, combining, and organizing, the parts and mechanifm of fteam-engines, fo as to make them more commodious and portable, and alfo in the mode of regulating their velocities, and in leffening the wafte of power.

Dated February 5, 1801.

James Power, of St. Edmund's Bury, Suffolk; for a portable oven, on a new or improved conftruction. Dated February 5, 1801.

Joseph Gaston John Baptiste Count de Thiville, of Piccadilly, Middlefex; for certain new methods of giving an independent moving power to all machines, by means of hydraulick engines; and alfo of conftructing and employing feparately feveral of their parts, fuch as wheels, piftons, and apparatus for reducing friction, upon new principles.

Dated February 5, 1801.

James

JAMES ANDERSON, of Mounie, in the ſhire of Aberdeen, Doctor of Laws; for a method of œconomiſing fuel in the heating of houſes, and for improving the conſtruction of hot-houſes. Dated February 10, 1801.

JAMES WELDON, of Litchfield, Staffordſhire, Engineer; for his farther new-invented machine or mill for grinding bark, and various other articles, for which he obtained former letters patent in January, 1798; and which machine or mill, ſo improved, may be applied to ſeveral other uſeful purpoſes. Dated February 10, 1801.

WILLIAM JOHNSON, of Widmore - Houſe, Bromley, Kent, Gentleman; for a machine which has the principle of its motion within itſelf, denominated the perpetual motion, or mechanical ſelf-moving power. Dated February 10, 1801.

RICHARD SCOTT, of Chapel - Houſe, Suſſex, Lieutenant-Colonel in the ſervice of the honourable Eaſt India Company; for a method of preſerving papers, and other property, from being injured by fire. Dated February 10, 1801.

MARC ISAMBARD BRUNEL, of Bedford-ſtreet, Bedford-ſquare, Middleſex, Gentleman; for a machine for cutting one or more mortices, forming the ſides of, and cutting the pin-hole of, the ſhells of blocks, &c. Dated February 10, 1801.

WILLIAM WILDE, of Weſt Leake, Nottinghamſhire, Farmer and Grazier; for improved machinery, or apparatus to be attached or connected to harrows, whereby thoſe implements of huſbandry will execute their work to much greater advantage than by any mode hitherto practiſed. Dated February 17, 1801.

William Lester, of Cotton End, in the parish of Hardingstone, Northamptonshire, Patent Harrow and Chaff-Engine manufacturer; for his farther improvements upon an engine or machine for cutting hay and straw into chaff, for which he obtained former letters patent.

Dated February 17, 1801.

Matthias Koops, of James-street, Westminster, Middlesex, Gentleman; for a method of manufacturing paper from straw, hay, thistles, waste and refuse of hemp and flour, and different kinds of wood and bark.

Dated February 17, 1801.

John Bennòck, of Liverpool, Lancashire, Merchant; for a method or machine for making nails, bolts, rods, watch-springs, clock-springs, and metal plates.

Dated February 17, 1801.

Thomas James Plucknett, of Deptford, Kent, Gentleman; for improvements in capstans and windlasses for ships, and other purposes.

Dated February 26, 1801.

Robert Gibson, of the Adelphi, Middlesex, Wharfinger; for a windlass upon an improved construction, which may be applied to ships, and other useful purposes.

Dated February 26, 1801.

Printed by Nichols and Son, Red-Lion-Passage, Fleet-Street, London.

REPERTORY

OF

ARTS AND MANUFACTURES.

NUMBER LXXXIV.

Printed by Nichols and Son, Red-Lion-Paſſage, Fleet-Street, London.

LVI. *Specification of the Patent granted to* Edmund Cartwright, *of the Pariſh of St. Mary le Bone, in the County of Middleſex, Clerk, M. A.; for various Improvements in the framing, combining, and organizing, the Parts and Mechaniſm of Steam-Engines, ſo as to make them more commodious and portable; and alſo in the Mode of regulating their Velocities, and in leſſening the Waſte of Power.* Dated February 5, 1801.

WITH A PLATE.

TO all to whom theſe preſents ſhall come, &c. Now know ye, that in compliance with the ſaid proviſo, I the ſaid Edmund Cartwright do hereby declare, that my ſaid invention conſiſts,

Firſt, in ſo diſpoſing the different parts of the ſteam-engine as that the boiler, the cylinder, the fly-wheel, and all the moving parts of the engine, ſhall be embraced by, comprehended within, or attached to, a frame erected upon the boiler, and ſo connected together as to make one whole or

perfect machine; so compact as to be easily portable; and requiring no farther trouble and expence, after it is finished at the manufactory, than to place it upon the fire; when it will be immediately ready for the office for which it is intended. For this purpose it will be most convenient to make the boiler oblong, and straight-sided, with a flat top. I place the cylinder within the boiler, a position which has, indeed, been already adopted by others, though for a different purpose. The frame extends lengthways on the sides of the boiler, and may project a little beyond that end of the boiler, where I fix the air-pump and condenser. To the part of the frame so projecting, the air-pump and condenser may be attached or suspended. Across the frame is an axis, with a pulley upon it, round which goes a chain or strap, to the top of the piston-rod. Upon this axis is a crank, from which goes a connecting-rod to a lever, lying horizontally on the top of, or alongside the boiler. Besides the axis above mentioned, there is another axis lying across, either immediately above or below, or on one side, of the former one. Upon this axis, which is the axis of the fly-wheel, is a crank, from which goes a connecting-rod to the same lever, that was spoken of before.

Now it is evident, that when the pulley is put in motion by the action of the piston, the crank upon its axis will move the crank upon the axis of the fly-wheel, as they are both connected to the same lever. If, therefore, the pulley is made to move in a direction from A to B, (see Plate XVII. Fig. 1,) and back again, by the action of the piston, and its counterweight; and if the crank upon its axis moves in the same direction likewise,

likewiſe, the crank upon the axis of the fly-wheel will alſo do the ſame, unleſs it is made, as it muſt be, of ſuch a determinate length as that when it reaches the extremity of its motion it can paſs forwards; in that caſe a rotary motion is produced of the fly-wheel. Again, if the crank upon the axis of the pulley is ſo diſpoſed as that when the pulley moves from A to B, or through any ſpace not exceeding a complete revolution, (ſee Fig. 2,) the crank ſhall paſs from C to E, through D, or in that direction, according to the ſpace through which any given point of the pulley paſſes, the crank will give two vibrations to the lever for one ſtroke of the engine, which will give two revolutions of the fly-wheel in the ſame time. Again, if the diameter of the pulley be ſo reduced as that the ſtroke of the engine ſhall make the pulley revolve once and a half round, and back again, the crank will occaſion the lever to vibrate three times for every ſtroke of the engine. Again, if the diameter of the pulley be ſo reduced as that it ſhall make two complete revolutions, and back again, for one ſtroke of the engine, in that caſe the crank will give four vibrations to the lever for one ſtroke of the engine, and the fly-wheel will revolve four times. By this invention the fly-wheel may be made to run with any requiſite velocity without the intervention of any kind of wheel-work.

Secondly. For the purpoſe of leſſening the waſte of power, and regulating the velocity of the engine, inſtead of making the governor act upon the throtle-valve, I make it act immediately upon the ſteam-valve, by cauſing it to give motion to a wedge, ſliding at liberty, backwards and forwards, under the weight which keeps the ſteam-valve open.

 If

If in any particular caſe it ſhould be thought convenient to have the fly-wheel below, its axis muſt be placed underneath the lever, connecting it to the lever by a rod as before.

Thirdly. When I want to obtain a reciprocating motion horizontally, I extend the connecting-rod of either crank as far below the lever as may be neceſſary, and at the bottom; that which is wanted to have a reciprocating motion hangs to it in a joint (ſee Fig. 3).

The air-pump, as well as any other pump that may be wanted, is worked by a lever, which receives action from a pulley on the axis put in motion by the piſton. And to ſuch lever is applied the neceſſary counterweight.

If the engine is a double one, there muſt be a double chain or ſtrap round the pulley, ſo that the piſton may act upon the pulley both in its deſcent and aſcent. Or the action may be given to the axis of the crank by a rack and pinion.

Fig. 4, a ſide-view of the engine as ſpecified above.

A, the cylinder.

B, the boiler.

C, pulley, put in motion by the piſton and its counterweight.

D, the crank upon the axis of the pulley.

E, the connecting rod.

F, the lever.

G, the fly-wheel.

H, the crank upon its axis.

I, Rod connecting it to the lever F.

Fig. 5, an end-view.

Note. The air-pump, condenſer, valves, working-gear, &c. are omitted, as not neceſſary to explain the nature of my improvements. In witneſs whereof, &c.

LVII.

Fig. 4.

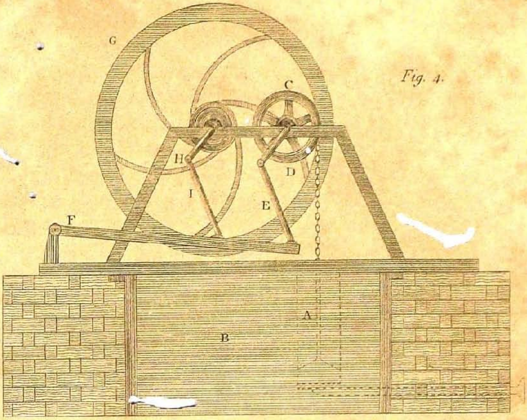
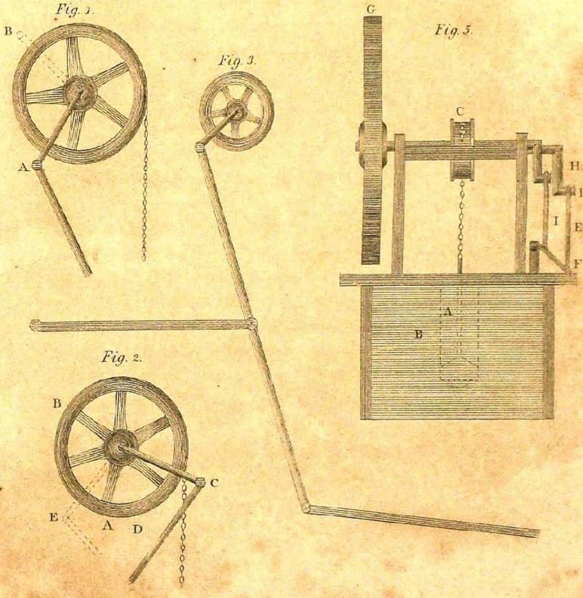


Fig. 1. Fig. 3. Fig. 5. Fig. 2.



LVII. *Specification of the Patent granted to Mr.* JAMES POWER, *of Saint Edmund Bury, in the County of Suffolk, Whitesmith, for his Invention of a Portable Oven, upon a new or improved Construction.* Dated February 5, 1801.

WITH A PLATE.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said James Power do hereby declare, that my said invention is described in the drawings and descriptions thereof hereunto annexed. In witness whereof, &c.

Power's Portable Oven is here given to the scale of 1 inch to the foot, and 2 feet deep *. Fig. 1, (Plate XVIII.) represents the oven detached, so constructed as to be set over a laundry, or any other small stove. Fig. 2 represents the oven and hot closet complete. Fig. 3 is the inside view of Fig. 2. A, the hot closet, which is gradually heated to any degree, by means of the large valve, in the chimney G. F, is the splitter, so called because it divides equally the heat of the fire, and throws it up the flues *a*, *a*, and heats both the oven and hot closet. In case the splitter should retain too great a heat for the oven B; *b* is a valve, for the reception of air, which may be regulated at option. H, is the small valve (Fig. 8,) made round, and fixed about 2 inches from the front of the oven, with holes in the sides, to secure it from the soot

* Reduced from the original to ½ an inch to the foot.

falling

falling into the oven; the uſe of this valve is in caſe any nauſeous ſcent may ariſe from baking; a current of air paſſes through the ventilator C, and carries the ſcent into an open chamber I. The large valve is about 12 inches from the extremity of the oven. K, is the ſcraper, a piece of iron, carried over the hot cloſet, which, when pulled out by the two handles *d*, *d*, ſcrapes the ſoot which adheres to the top, and carries it down the flues into an open chamber L, and is ſwept out of the doors E, E, by a bruſh. C, the furnace, which is about 8 inches ſquare at bottom, and regularly paſſed * up the ſides, front and back. *e*, *e*, *e*, *e*, are baking tins. D, the cinder-hole. Fig. 4, is a baker's oven, ſimilar in conſtruction to the former one; but with theſe exceptions, it is 4 feet long, 2 deep, and 2½ high, with three ovens, two of which are regulated by ventilators at bottom. L L, is an open chamber, to prevent too great or ſudden heat from the ſplitter. Fig. 6, the ventilator, which is turned by the handle *f* to enable *g* to admit or ſecure any quantity of air. Fig. 7, the large valve, which is placed in the chimney G, and acts as a damper, to graduate the heat to the hot cloſet; it is made with ſheet-iron, like the oven, the ſize of the oven-pipe, turned by a ſtrong thick wire handle in its centre. Fig. 8, is on the ſame conſtruction, except being cloſed at the top, and holes in the ſides already ſpecified, and rendered, when down, air-tight by two pieces of iron on each ſide, *i*, *i*. The ſplitter is formed of ſheet-iron, as in Fig. 5.

N. B. The ſize of the oven may be varied as circumſtances may require.

* Compared with the record in the office.

LVIII.

Fig. 1.

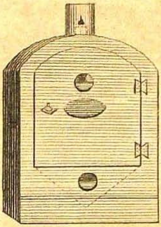


Fig. 2.

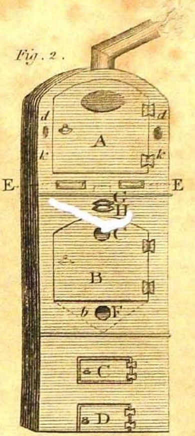


Fig. 3.

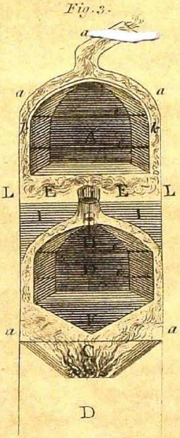


Fig. 4.

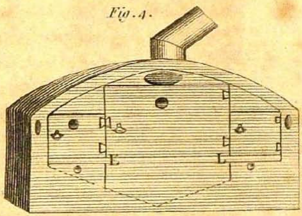


Fig. 5.

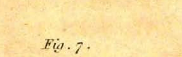


Fig. 6.

Fig. 7.

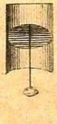
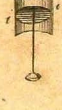


Fig. 8.



LVIII. *Specification of the Patent granted to Mr.* John Longman, *of Penton-ſtreet, Pentonville, in the Pariſh of Saint James, Clerkenwell, in the County of Middleſex, Organ-Builder; for certain new Improvements in the Conſtruction of Barrel-Organs, to prevent them from getting out of Order; and that another Muſical Inſtrument or Inſtruments may be internally united or attached thereto, and made to play with the ſame Barrel.*

Dated January 27, 1801.

WITH A PLATE.

To all to whom theſe preſents ſhall come, &c. Now know ye, that in compliance with the ſaid proviſo, I the ſaid John Longman do hereby declare, that my ſaid invention is deſcribed by the above drawing, (ſee Pl. XIX,) and alſo in manner following: that is to ſay: The part of barrel-organs employed in fixing the tune has hitherto been detached from the barrel and key-frame, whence many and continual muſical imperfections ariſe. I therefore attach to the barrel a circular plate or plates, of any metallic or other ſubſtance, to which is adapted a proper key-frame, (as deſcribed in the above drawing); by this is gained a regular, preciſe, uniform movement of the barrel, without any reverberatory motion whatever. The nice and ſteady connection of the plate or plates fixed to the barrel with the key-frame is the principle which gives not only variety of mechanical adaption, but alſo accuracy of execution to this above all other barrel-organs. A reverſe method may be uſed by having the wheel A, which

which is fixed to the barrel, made thick enough to contain a number of grooves cut round it, and the plate B, which before was called a notch plate, to be a plain piece of metal, to run in the above-mentioned grooves.

Fig. 2. The ſpiral barrel is made by cutting one part of the wheel A, and inclining one of the parts one way, ſo that when the key-frame comes to that part of the wheel, the inclined part gradually draws the key-frame until it receives the next notch in the plate B, and has then paſſed one round.

Fig. 3. The exact connection which my diſcovery gives to all parts of barrel-organs with each other enables me to add, with great advantage, as accompaniments, bells, tambourins, &c. to improve and enlarge the force and beauty of the inſtrument. The inſtrument thus improved, with or without accompaniments, is not liable to be injured by change of poſition or carriage. In witneſs whereof, &c.

References to Plate XIX.

Fig. 1. A, the plates on the barrel. B, notch plate to receive the plate A. C, a roller, and A one of the plates, either of which may be uſed to keep the key-frame a proper diſtance from the barrel. D, the bell action. E, the Bells. F, an index directing to place the tunes.

Fig. 2. A, plate on the barrel. B, notch plate on the key frame.

Fig. 3. Side-view of the bell action.

LIX.

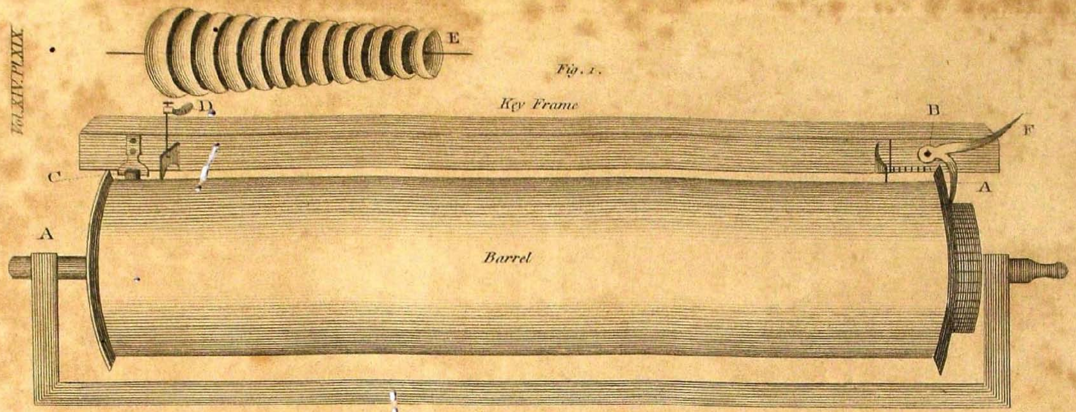


Fig. 1.

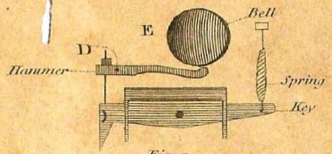


Fig. 3.

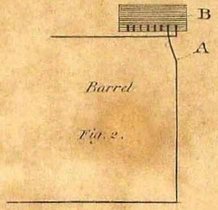


Fig. 2.

LIX. *Specification of the Patent granted to Mr.* Isaac Hadley Reddell, *of Birmingham, in the County of Warwick, Gentleman; for a new Method of constructing Carriages for the Conveyance of Merchandize either by Land or Water; which Carriages may be removed (either loaded or unloaded) from the Land to the Water, or from the Water to the Land, with Ease, Expedition, and Safety.* Dated August 2, 1800.

To all to whom these presents shall come, &c. Now know ye, that in compliance with the said proviso, I the said Isaac Hadley Reddell do hereby declare, that the following is a description of the carriages which are made according to my method; that is to say: I make the bodies of the carriages to any form or size required, chiefly of wood, and strengthen or fasten the parts together with iron, or any other suitable substance, and make the bottoms, ends, and sides of them as water-tight as possible. I then affix a suitable number of wheels thereto, by means of an axletree, or axletrees, or in any other eligible manner (but in most cases it will be best to place them so that the bottom of the carriage or carriages may not be more than six, or less than three or four inches above the level surface of the ground). I sometimes place the wheels, in suitable recesses, in the sides of the boat-parts, or bodies, of the carriages, and put either a broad plank, or some strong iron work, over their centres, in order to support and protect them; or they may be fixed in narrow water-tight compartments, or boxes, in suitable places in the inside of the boat part, or body, of the carriage, but of course the number of the wheels, and the manner of fixing them,

 must

muſt be varied according to circumſtances. When they are in the water, a conſiderable number of the ſmall-ſized carriages may be faſtened together, in any eligible manner, and hauled by one horſe; and if they are wanted out of the water they muſt be ſeparated, and drawn up an inclined plane by one or more at a time. They may then be taken up, or let down, a plane, to a higher or lower level of water, as circumſtances may require, or be drawn by land (either loaded or unloaded) to any place wherever they may be wanted, very near, if not quite, as readily as a common waggon or cart. Carriages of this deſcription may be made to carry any reaſonable burden, that is to ſay, from one ton to twenty tons and upwards, according to the uſes for which they are intended; ſuch as are meant to be drawn about when on the land by two or three horſes would be beſt, if calculated to carry about two or three tons. They may be made principally with ſquare ends, and may be either linked, tied, or grappled, to each other when they are in the water, or a rope or ropes, chain or chains, may paſs through either rings, loops, or holes, made in, or attached to, each of them; and by means of a lever, weight, or ſpring, in one or both of the end carriages, they may be braced together ſufficiently tight. The foremoſt end of the body of the leading carriage, if it is deemed neceſſary, may be made in the uſual cut-water form, and the hindmoſt may have a rudder attached to it, which may be taken off, or put on, at pleaſure, and they all may be ſteered together as one boat. In canals, where the water is on different levels, if a ſufficient quantity cannot conveniently be ſpared from the upper level for the ſupply of

locks,

locks, it will be extremely eligible to have carriages of the aforesaid description to carry about six or eight tons each, and when three of them are fastened together in the water, they will be equal in size and appearance to a common canal coal-boat, and to pass them from one level to another it would be necessary to have an inclined plane or planes to go down into the water at the head of the upper level, and another from thence down into the water of the lower level, and of course a certain degree of power would likewise be necessary to let down, and draw up, the carriages on the inclined planes. A small steam-engine, somewhat like those which are used at several of the collieries in the kingdom, to draw the coals out of the pits, if well executed, would pass upwards of two hundred tons over the planes in an hour, if the difference in the levels was not more than twenty or thirty feet, and the expence of making the planes, and erecting the engine, would not be much more, if so much, as making four common locks, with the necessary appendages; or any other power might be made use of that was thought more eligible. If still greater dispatch is required, the machinery may be made a little stronger, and carriages of nine or ten tons burden or more may easily be taken over the planes, and they may be so constructed that when two of them are fastened together in the water, they would form but one complete boat in size and appearance, of course they may pass the locks together as one boat, if there are any locks on the line of the canal where these boat-carriages may be used, or pass the planes separately, with expedition and safety. In witness whereof, &c.

LX. *Description of a Door or Chest Lock, of a peculiar Construction, for securing Property from Picklocks and Housebreakers. By Mr.* Thomas Arkwright, *of Chorley Moor, Lancashire.*

WITH A PLATE.

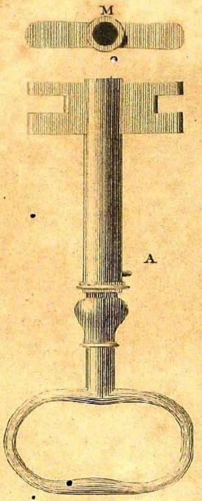
From the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.

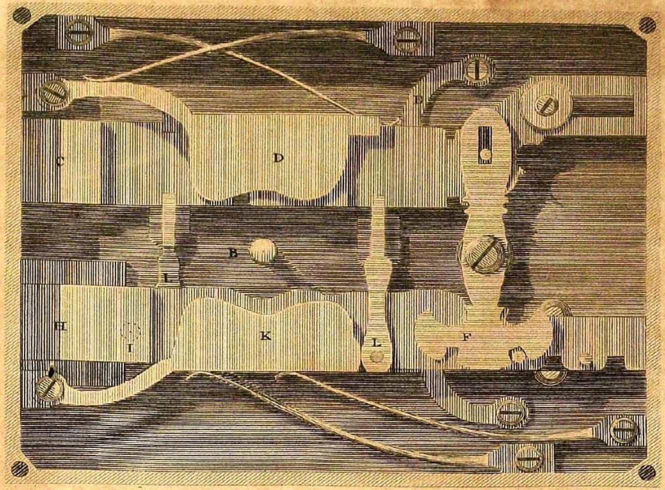
Fifteen Guineas was voted to Mr. Arkwright for this Invention.

THIS lock has two bolts, so formed, that, if the key should by any accident be left in the lock, it would be scarcely probable that a servant could unlock them.

References to Plate XX.

A, the pointer on the shank of the key.
B, the pin on which the key turns.
C, top bolt of the lock.
D, the upper higher tumbler for the top bolt.
E, another tumbler for the top bolt, and placed underneath it.
F, a lever, which works both bolts, and moves on a centre G.
H, the lower bolt, with a joint I upon its head.
K, the lower tumbler, with two joints L, L, which fall into two notches of the top bolt. Underneath the lower bolt is another tumbler, similar to that marked E. There are five springs within the lock, four of which act upon the upper


M
A


C
D
E
B
L
L
H
I
K
F

per and lower tumblers, the other on the joint bolt H.

M, the bottom part of the key. The dark ring in the centre reprefents the hollow to be applied to the lock-pin B, above mentioned.

Directions for workng the Double-bolted Lock.

Firft, place the head or bolts of the lock towards the left hand; then take the key with the right hand, with the fmall pointer A, in the fhank of the key, towards the right: after this, put the key down to the bottom of the focket upon the centre pin B, in the lock, and give one half-turn with the pointer in the fhank of the key, upwards; by which the bolt C at the top will be locked. In the next place, draw back the key about one inch, fo that the webs or bits of the key may clear the tumblers in the lock; then turn the key with the fmall pointer towards the right hand, and put down the key in the manner above mentioned. After this, make one half-turn with the pointer in the fhank of the key downwards, by which mean the lower bolt H is locked, and the higher bolt C unlocked. Then draw up the key as aforefaid, and turn it with the pointer in the fhank to the right hand. In the laft place, thruft down the key, and give one half-turn with the pointer in the fhank of the key, upwards, by which means both the bolts C and H will be locked; fo that, when the bolts are to be unlocked, the pointer in the key muft be towards the left hand, and muft be worked as above directed.

LXI. *Deſcription of a Loom to weave figured Ribbands. By Mr.* THOMAS CLULOW, *Old Cock-Lane, Shoreditch.*

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

THIS loom differs from the common figured ribband-looms in the method of forming the figure, which, in the old mode, was tedious, from the work being ſtopped, whilſt the figure was drawn by the hand.

In the preſent loom the tire cords, which form the figure, are drawn or worked by a cord or leather ſtrap fixed to the centre treadle, which ſtrap paſſes over two vertical and one horizontal pulley to the back of the loom, and has a weight hung to the end thereof: upon this ſtrap, above the weight, is fixed an iron, of a bevel or ſloping form, which, when the ſtrap is pulled up by preſſing with the foot upon the treadle, raiſes a wire lever placed acroſs the main wheel of the movements placed vertically, and allows this main wheel to move one fourth of its circumference, where it is ſtopped by an iron pin, placed on its rim, and prevented from returning by a clitch or catch on the edge of the wheel on its right ſide. Within the rim of the main wheel is a ſmall catch-ſtrap connected with the ſtrap above mentioned; this catch-ſtrap pulls forward the main wheel one-fourth of its circumference until it is ſtopped by the wire lever, and one of the

the pins on the rim, of which there are four in number in the round.

There are alſo four iron pins projecting from the left ſide of the main wheel in oppoſite quarters of it; theſe act on a hanging lever, to the lower part of which a ſtring is attached which paſſes behind the box, containing the whole machinery, and raiſes four clicks or catches on four rollers, which permits any one of the four rollers to run back as the figure may require, each roller, by ſuch motion, drawing up the number of threads neceſſary to form the figure, by cords extending from theſe rollers over pulleys to the paſs-cords, which draw the figure.

LXII. *Experiments on Evaporation.* *By* C. Wistar, *M. D.*

From the Transactions of the American Philosophical Society.

IN an Eſſay publiſhed in the laſt Volume of the Tranſactions of the Society, I deſcribed a ſpecies of evaporation which was excited by ſuſpending ice, at the melting point, in air reduced to the temperature of 0 of Fahrenheit's ſcale; and conſidered it as the effect of a general law of nature, in conſequence of which an inelaſtic vapour, (which commonly is viſible,) ariſes from water, and from wet ſubſtances, whenever they are warmer than the atmoſphere which ſurrounds them.

From

From facts stated in the same paper it was inferred, that this inelastic vapour does not depend upon any positive quantity or degree of sensible heat in the evaporating body, but upon a relative degree, exceeding that of the atmosphere to which it is exposed; and that it is produced by the passage of heat from the moist body into the contiguous air.—If this theory be true, it follows that a slow distillation may be performed, with the common apparatus, by applying cold to the receiver or refrigeratory, without increasing the heat of the retort or substance to be distilled, as there will be a continual passage of heat from the body to be evaportaed or distilled, into the air of the receiver.

Although, for the reasons there given, I had no doubt of the truth of the doctrine advanced in my former paper, I was desirous of submitting it to the test of this experiment, because it has been suggested that the vapour which appeared to arise from ice might have arisen from the mixture of different proportions of air of different temperatures; whereas by distilling or evaporating in a luted retort and receiver, there can be no mixture of warm and cold air; and by using a substance which is not contained in the atmosphere, we shall avoid all suspicion that the vapour which arises from it may have originated from the air in the vessels.

With these views I poured an ounce and half of vitriolic æther into a retort, and luted it to a receiver with a long neck, which was placed in a mixture of salt and snow, while the retort was surrounded by air of the temperature of 50° of Fahrenheit. The frigorific mixture, from the impu-

rity of the ſalt, was ſeldom below 10°, ſo that the difference, between the æther in the retort and the air in the receiver, did not exeed 40°.

When the apparatus had been thirty hours in this ſituation the frigorific mixture was removed, and one third of the æther was found diſtilled into the receiver.

I believe no cauſe can be aſſigned for this diſtillation but the paſſage of heat through the æther into the cold air of the receiver; and to be certain that the application of cold to the receiver *really produced it*, I prepared a ſimilar diſtilling apparatus, in the ſame manner preciſely, and placed the retort in contact with that of the other apparatus, while the receiver, inſtead of being chilled by the cold mixture, ſtood in air of the ſame temperature with the retorts, *viz.* 5°; but no diſtillation took place during thirty hours.

To vary the experiment, I placed ſome camphor in another apparatus prepared as above, and fixed the receiver in the frigorific mixture, while the retort ſtood in air of the temperature of 50°; at the expiration of thirty hours ſome of the camphor was found ſublimed, and the ſublimate had thoſe arboreſcent appearances which uſually attend it when produced by heat.

LXIII. *Account of Experiments in cultivating Rice. By the Right Hon. Sir* Joseph Banks, *Bart. K. B. and P. R. S. In a Letter to the President of the Board of Agriculture.*

From the Communications to the Board of Agriculture.

April 15, 1799.

As I conceive the introduction of new esculent vegetables, a matter of material importance to the agricultural interests of this country, and that even an unsuccessful experiment on this subject may be, though not perhaps fitting for publication, a proper document to be lodged in the archives of the Board of Agriculture, I take the liberty of submitting the following remarks to your Lordship's better judgment.

The dry, or mountain rice, which I received last year from the Board of Agriculture, for trial, had been procured at some considerable expence by Sir John Murray, from the neighbourhood of Serinagur, a city in India, situated at the foot of Mount Imaus, where snow lies till late in the spring; and where the climate has been supposed to resemble that of England, sufficiently to make it probable, that the vegetable productions of the one, would equally succeed in the other country; I consider it as a duty owing to the patriotic exertions of Sir John, to give your Lordship and the Board, some account of the result of the trial of it, made by me at Spring Grove, near Hounslow, in Middlesex.

It

It was not till near the end of May, when the samples, being of six sorts, were delivered out by the Board, and they were sown immediately, on the 21st day of that month, on six small beds in a garden, under the shelter of a pale, in a south exposure.

The grains were sown very thin, in order that the progress of their vegetation might be better noted; in a very few days they appeared above ground. The season being warm, with a moderate supply of rain, it was seldom necessary to water them; however, when they appeared to flag, which generally happened after three or four dry days had taken place, they were well sprinkled with a watering pot.

In less than a month they had grown several inches high; each sort had acquired an appearance very different from the rest; some were pale green, and had broader blades; some were deeper coloured, and narrower in the blade; and one sort had a brown hue on the whole plant; and the bases of the leaves in this kind were nearly black.

During the month of August, they tillowed much more than I have observed any other corn to do; so much so, that although they had been sown very thin, they became a dense compact bed of plants; the blades in some of the kinds standing as close or closer to each other, than the thickest sown barley ever does.

At the close of the month, the blades were from a foot to eighteen inches high; the plants continued to tillow, each root having by this time produced from ten to twenty offsets, but no symptom of a rising stem was at all observable.

In the middle of September, they had still continued to tillow, and the blades to lengthen, so

that ſome of them were at leaſt two feet long. As the froſts of the autumn were nearly now approaching, it became an object of ſome importance to examine the ſtate in which the plants really were, in order to aſcertain the probability of their having produced ears, or poſſibly of their having ripened corn, if they had been ſown a month or two earlier. The moſt careful inſpection was therefore made by diſſection, but no traces could be found of the rudiment of a joint beginning to form itſelf on the crown of the root, or of the embrio of the glumes of the ear, which in all kinds of corn are firſt diſcernible in that part.

About this period I was taken ill, and obliged to deſiſt from obſerving their future progreſs; but a froſt ſoon after followed, which cut the blade down to the earth, and at once deſtroyed all hopes of theſe kinds of rice producing grain in our climate: the quantity of the blade was however ſo uncommonly great, that it is not impoſſible it might be advantageous to ſow it as food for cattle, for a very large proportion of ſtock might certainly be maintained upon an acre of it.

Before the froſt ſet in, I had ordered a tuft of each kind of the rice to be tranſplanted into a pot, and placed in a hot-houſe, in order, if poſſible, to aſcertain the natural period of this grain; whether, like winter corn, it requires eight or nine months to come to perfection, or, like our Lent corn, arrives at the ſame period in five or ſix; but all of theſe died, notwithſtanding great attention was paid to them: ſome ſeed however, which I had given to Mr. Lambert, ſucceeded better; it was ſown in his hot-houſe in the month of June, where it throve well, but did not produce ears till near Chriſtmas, a period of ſeven months; from whence

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as it is not probable the grain would have rippened in leſs than two months from the time when the ear appeared, it is eaſy to deduce, that in the neighbourhood of Serinagur, theſe kinds of rice are either ſown as winter corn, or the climate there, is far better ſuited to promote the quick progreſs of vegetation, than ours is. It was, when it produced ears, about three feet and a half high, and ſome of the ſtems had five joints, including the radical one: had it been in a more ſuitable climate, it would certainly have grown taller, for the flowers dropped off without producing ſeed.

In the courſe of this ſpring I have forwarded a few ſeeds, which were left from Sir John Murray's importation, to Portugal; if they ſucceed, I ſhall probably hear of it; and in that caſe, if your Lordſhip feels intereſt on the ſubject, I ſhall certainly do myſelf the honour of communicating ſuch information concerning them, as I am able to obtain.

LXIV. *Effect of the Equiſetum Paluſtris upon Drains. By the Right Hon. Sir* JOSEPH BANKS, *Bart. K. B. and P. R. S. In a Letter to the Secretary of the Board of Agriculture.*

From the COMMUNICATIONS to the BOARD of AGRICULTURE.

Woburn, June 21, 1798.

DURING the laſt very pleaſant week we have ſpent together at the Duke of Bedford's ſheep ſhearing, while you, and the reſt of his Grace's gueſts, were

were employed in confidering and re-confidering the merits of the very excellent ftock that was daily exhibited to us, I, who am lefs converfant than moft of them in thofe minute differences which raife the value of a tup from £.50. to £.500, employed myfelf, under the conduct of Mr. Farey, his Grace's fteward, in vifiting and carefully examining the extenfive fyftem of drainage and irrigation, now carying on, by that gentleman upon the Duke's eftate.

Few objects of agricultural utility have ever interefted me fo much, and I have no hefitation in faying that none are, in my opinion, fo interefting to the increafing profperity of the landed intereft of this kingdom, as the theory of draining whole diftricts, by tapping the mother fprings that overflow their furface, and conducting drains through the principal valleys, fo contrived as not only to render the boggy parts of them found land, but alfo to free the fides of the hills which form them, from all out-burfts of water.

Mr. Elkington is certainly the father of this fyftem of drainage, but Mr. Farey has perfectly comprehended all the works done by that gentleman, for the Duke, and in the mode of conducting the operations now carrying on, has, in fome inftances, excelled them, founding his practice on an extenfive and enlightened theory, applicable to all valley bogs, in the drainage of which, it appears to me almoft impoffible that his method fhould fail, under any circumftances.

One thing, however, has occured, in the fhort experience of the Woburn operations, (about five years), which appears to me of confequence enough to warrant the trouble this will give to you and the Board. Some bogs, drained by under

drains

drains made at a great expence through the moſt miry parts of them, appeared at firſt perfectly dry, but have ſince been found to grow by degrees leſs and leſs ſo. On examination, theſe drains have been found more or leſs choked up by a plant vegetating within them, and forming both ſtems and roots, the whole ſeveral yards in length, intercepting the courſe of the water, weakening the current by degrees, and at laſt wholly choaking up the drain.

This plant is the *equiſetum paluſtris*, a weed common in mooriſh and ſwampy places, but hitherto little noticed by Naturaliſts; its root, or rather its ſtem under ground, is a yard or more in length, and in ſize like packthread; from this, a root of twice the ſize of the ſtem runs horizontally in the ground, taking its origin from a lower root, which ſtrikes downwards perpendicularly to a depth I have not hitherto been able to trace, as thick as a ſmall finger; this perpendicular root forms in ſome places beds, which occupy a large portion of the more ſolid part of a peaty bog, as may be ſeen in ſome parts of the banks of the Duke's open drains.

As the bud by which the plant appears to renew itſelf in ſpring, is ſituate on the horizontal root, a yard or more in depth, the ſhoot muſt, in its progreſs upwards, be liable to meet with under drains, and penetrate into them, through the openings left for the paſſage of the water. When once entered, nature, which has given to the plant the power of piercing the ſoil upwards from a great depth, enables it to live in the confined atmoſphere of a drain, where, as it is continually drawn forward by the current, the joints lengthen themſelves beyond their natural dimenſions; hence it is probable that when drains choaked with it, are taken

taken up and carefully examined, the length of the plants will be found very much to excel thofe I have obferved.

Had you not afked me for this flight account of a fubject I have fo imperfectly inveftigated, I confefs I fhould not have ventured to put it upon paper: I hope, however, that it will lead to further difcuffion, and fhall feel real fatisfaction if the end of the difcuffion fhall produce a remedy for this evil, which feems likely to put a total ftop to the practice of draining bogs, where this mifchievous plant grows, by under drains; it is neceffary, however, for the evil to be known, in order that thofe who poffefs bogs that have become miry after being drained, may be apprifed of an evil, which can certainly be cured by the fimple expedient of cafting the under drains into open ones.

LXV. *On the Smut in Wheat, Blights, and the Manner in which Plants are nourifhed. By Sir* JOHN CALL, *Bart. M. P. In a Letter to the Prefident of the Board of Agriculture.*

From the COMMUNICATIONS to the BOARD of AGRICULTURE.

April 29, 1799.

HAVING often reflected upon the nature of fmut in wheat, and confidered the various propofitions and fuggeftions which had been made from time to time, for cleanfing the grain, fo as to prevent

prevent its affecting the flour ; as alſo to prevent the ſmut from being propagated into the ſeed wheat ſo affected, I was led to deliberate in my own mind whether the ſmut was a diſorder, or diſeaſe, inherent in the ſeed, or an adventitious effect from the atmoſphere ; or ſome animalcula depoſited in the ears of corn, during their growth. In reaſoning on this ſubject, it occurred to me, that if the diſorder, or diſeaſe, called the ſmut, was inherent in, or latent in the ſeed grain, and that all ſuch grain, when ſown, would produce only ears full of ſmut ; then, unleſs the diſorder could be cured by ſome previous application, there would be a riſk of having all the crops rendered abortive, where a remedy was not applied ; or if, as ſome perſons had ſuppoſed, that the nature of the ſoil had contributed to produce the ſmut in wheat, then ſuch ſoil, unleſs it could be corrected, would become unfit for, or dangerous to tillage. To ſatisfy myſelf at leaſt how far the ſmut was a diſorder liable to be propagated by ſeed grain taken out of ſmutty ears, or other grain mixed up with, and rubbed in ſmut, I reſolved to make the following experiment.

In the year 1797, when my men were threſhing out my wheat, I deſired them, as well as ſome of my neighbours, to ſave all the ears they met with which were affected with the ſmut ; having collected all I could get, previous to the beginning of October, I found ſome ears wholly decayed, ſome with one, two, or more grains, apparently perfect, all which I cauſed to be rubbed out with the hand in a bag of paper, ſmut and all together ; and after mixing and rubbing the grain in the ſmut, all I could get perfect out of ſmutty ears amounted

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to 72 grains, which were carefully dibbled in, and marked in a ridge amongſt other wheat, in a field then under tillage. Their growth from the firſt was ſimilar to the reſt of the field. The certificate which I deliver herewith, and the ſpecimens of about 60 ears, gathered from the produce of the 72 grains, among which are contained every ear that appeared diſcoloured, or was thought by the examiners to be tending to ſmut, will ſerve to corroborate my opinion; which, as I obſerved before, is, that certain animalcula are depoſited in the huſks which cover each grain, about the time the wheat is in bloſſom, which are fed and brought to perfection by devouring the juice, or milky ſubſtance which riſes at the root *, and that if not intercepted would form a complete grain. Inſtead of which, as in many other caſes of vegetation, the vegetable life, as I may ſo call it, is deſtroyed; and as a farther proof, that this is the caſe, and that the effect is not by the juices iſſuing from the earth, or riſing through the tubes of the ſtalk, I need notice no other effect, than, that ſome grains periſh and become ſmutty, while others flouriſh and become perfect in the ſame ear of corn; whereas, was the diſeaſe, which is ſuppoſed to occaſion the ſmut, radical in the original grain of ſeed wheat, or infectious from the juice ariſing through the pores and tube of the ſtalk, all the grains in each ear would be affected, or thoſe more particularly at the lower part; whereas the grains decayed are often found intermixed with others quite perfect, and diſperſed throughout the ear.

* The root here meant, is the root of each grain in the huſk.

ear. I therefore truſt, that the prejudice conceived, that the ſmut in wheat is an inherent diſorder, will be relinquiſhed; or that another idea, that one kind of ground is more likely to produce ſmut than another, will be abandoned. I do not deny that a conſiderable degree of ſmutty wheat threſhed out, and the ſmut of it mixed with other pure grain, will injure and prejudice the white caſting of the flour, and that it may be neceſſary to waſh and cleanſe ſuch wheat, previous to its being ground, where the ſmut evidently prevails; but I think my opinion of the origin of ſuch ſmut is much ſtrengthened by its prevailing more in one year than in another, and that it ſeldom happens the ſame complaint is made by farmers in two ſucceeding years, notwithſtanding there is no precaution taken, or remedy applied to the ſeed grain to prevent it; and with regard to my own experience during 29 years, I have neither mixed up my ſeed wheat with lime, nor ſteeped it in brine, nor waſhed it in any other liquid to prevent the growth of ſmut: nor do I believe any of my neighbours have made uſe of any ſuch precautions.

Analogous to this idea which I have juſt endeavoured to explain, I am tempted from obſervation to hazard another reſpecting the bloſſoms, and ſetting of young fruit, on fruit trees, but more particularly that of apple trees, in which a failure of fruit happens one, two, or three years together, and which is ſo detrimental to the produce of the orchards in Devon and Cornwall, that in the pariſh of Stoke Climſland, where I reſide, there have not been made, during the three laſt years, 500 hogſheads of cyder, whereas in a good

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bearing year there are ufually made from 1500 to 2000 hogfheads. This defect is generally afcribed to frofty mornings, cold winds, and blights, particularly to the latter; and I am apt to believe that it is in, and from the latter, where the mifchief arifes, not from any fimple effect of the atmofphere, but from the animalcula with which it is replete in fuch fogs, and which are depofited in the bloffom, as in a nidus, and there brought to perfection by feeding on, and deftroying the vegetable life by which they were originally nourifhed. Hence it is, that bunches of young fruit, fet, and grown as big as hazle nuts, fall off from the branches of the tree at the ftem, which feem to be eaten off, and deprived of the reception or conveyance of all nourifhment, and often crumpled up by a kind of web and dry leaves. To prevent the fuppofed effect of blight, cold wind, and hoar froft, on wall-fruit, a net is often hung up before them, ftuck full of dry fern, or other branches, to fhelter the trees, without obftructing the air; and others ftick in among the fruit trees, branches of firs, to cover and protect the bloffoms, both which modes probably have fome good effect, by intercepting and preventing the animalcula from taking poft in the bloffoms, or attaching themfelves to the root of the young fruit.

It is now three years that I have repeated the experiment of dibbling in, and fowing fome of the beft feed wheat, and fome of the moft fhrivelled grains, or tail part of the fame wheat, after winnowing; and from the refult of the experiments, I am fatisfied that a gallon of fhrivelled grains of wheat, retaining the power of vegetation, will produce a return of as good wheat in quality, and probably more

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in quantity, than a gallon of the finest grain of the same sort that can be separated by winnowing, or any other selection. The only advantage that I am disposed to grant, to fair, clean, and well screened seed wheat, is, that it will be more free from cockle, or any other extraneous seed, than the tail winnowings, or shrivelled seed, is likely to be; but on the other hand, a gallon of the shrivelled seed will contain three grains to two of the other, and probably will not be so much an object to be devoured by insects, birds, and vermin, as the more plump and full grains are; hence if my hypothesis is well founded, the advantage in favour of produce at the harvest will be in the shrivelled grains. A certificate to this effect will be found in the annexed paper.

The conclusion which I am disposed to draw from these experiments goes much beyond the advantage of converting the best kind of wheat, or other grain, to flour, and making use of an inferior sort for seed. I have been led to consider and revolve in my mind how far, and in what manner, any kind of manure contributes to the production of the crop: that it does so in the most essential manner. I do not entertain a doubt; but I differ from those who think that any kind of manure mixed with the earth, rises up through the roots, and forms any considerable part of the plant, fruit, or grain whatsoever: it may contribute to break the tenacity of the soil, to render it warm, open, and easy of perforation, so that the tender fibres, and roots of any plant may find an easy passage and genial protection therein; but I conceive that all the nourishment and juices necessary for the growth of the plants, and formation of their fruits

and

and ſeeds, is derived from the atmoſphere, that it enters and deſcends by the buds and heart of all vegetables, and the earth is only a protecting matrix to retain and ſupport all vegetable matter in a poſition to receive its nouriſhment. It is in forming, collecting, or attracting this nouriſhment, that manures are of ſuch importance to all kinds of vegetation, either by attracting and fixing the circulating atmoſphere, to hover over the earth where they are, ſo that the plants may imbibe what is proper for them ; or by cauſing ſuch a fermentation, or ſecretion in the earth, that by the attraction of heat it ſhould throw up ſuch a ſpecies of food and nouriſhment as is moſt congenial to that kind of vegetation for which the earth is cultivated.

I will not pretend to enter into a nice diſcuſſion of the cauſe and powerful effects of vegetation, or attempt to controvert any opinions which have been long held on the ſubject ; all I deſire is, that the ideas I have thrown out may be favourably conſidered, or the experiments fairly repeated, and that I may be allowed to think that a large turnip, weighing 5 or 6 pounds, with a very ſtrong and large top, held only to the earth by a ſmall tap root, and a few little fibres ; or that a cabbage weighing 20 or 30 pounds, ſtanding high on a ſmall ſtalk ; were not wholly formed and grew to that ſize by moiſture or ſubſtance riſing through their roots out of the earth.

LXVI.

LXVI. *Of the Preparation and Use of a Varnish of Amber, and its Application to stained Wood, with some Processes for staining different Kinds of Wood indigenous to Europe. By Mr.* Nils Nystrom, *of Norkoping, in Sweden.*

FROM THE *ANNALES DES ARTS ET MANUFACTURES.*

It is well known that stained woods require to be covered with a coat of the varnish of amber, or of linseed oil, in order to deepen the colour, and render it susceptible of a bright polish; the composition of these varnishes is therefore an object worthy our attention. The amber-varnish, as prepared in different places, is by no means uniform in its quality, whether owing to the negligence with which the melting of the amber is conducted, or to the manner in which the linseed oil is prepared, which becomes more or less inclined to dry in proportion to the degree of boiling which it has undergone. In order to ascertain the quality of such a varnish, it will be sufficient to apply it to any substance, and leave it, for twelve or twenty-four hours, to dry in an apartment, where the temperature is moderate: if in this space of time it becomes dry, we may consider it fit for use.

The best method of preparing it is the following.

Put a quantity of amber, pounded and sifted, into a melting-pan, so as to cover the bottom, which ought to be flat, to the height of an inch

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at moſt. Place this pan upon ſome ſupport, whereby it may be kept in an exactly horizontal poſition, over a briſk fire of charcoal, which muſt be kept burning with as uniform a heat as poſſible, till the amber is melted, and become perfectly liquid; the amber is then to be poured upon a plate of copper or braſs, in order that it may ſuddenly cool. When the amber has cooled, it is to be broken into ſmall pieces; and if its fracture exhibits a very deep ſhining brown colour, not more than about half as bright as it was before its fuſion, the amber will be fit for uſe.

A long courſe of experience has ſhewn that this circumſtance cannot be too much attended to. In fact, if the amber has not been ſufficiently melted, or if the fuſion has been imperfect, it will not diſſolve in the varniſh; if, on the contrary, the operation has been performed with a heat too violent, and too long continued, it will be burnt, and quite unfit for uſe.

When amber is placed over too weak a fire, it does not melt, but forms a ſort of deep brown incruſtation, which may likewiſe be employed as a varniſh, provided that it has not been too much evaporated. When it has loſt about one half of its weight, it will be in the ſtate moſt fit for uſe; if it has not been reduced to this weight, it muſt be put again into the melting pan, to bring it to the ſtate required.

During the progreſs of the melting, it ought to be carefully ſcummed of all its impurities, from which, however, we may obtain a varniſh of inferior quality.

For

For making varniſh it is not neceſſary to take the pure and tranſparent part of the amber; as our purpoſe may be anſwered by the ſmall yellow fragments of inferior quality, which may be purchaſed at half the price of the amber in lumps. The earthy particles contained in it ſeparate themſelves from the hot varniſh, if we ſuffer them to ſubſide before pouring off the liquid.

A flat-bottomed melting pan is preferable to one with a round bottom. The ſurface being more extenſive, the fuſion and evaporation proceed with greater rapidity. In round-bottomed melting pans, the amber lying very deep at the middle, is burnt in thoſe places where it lies the ſhalloweſt, before the fuſion and evaporation are completed.

Method of preparing the Varniſh of Linſeed Oil.

Take a pound of litharge, well pulverized and ſifted, four ounces of white vitriol, and a pint of linſeed oil. Put the whole into a melting pan, of ſuch dimenſions that they do not fill more than half; mix theſe ſubſtances well together, and make them boil till the whole of the moiſture has evaporated. This point of evaporation may be known by a pellicle, which forms itſelf upon the ſurface of the liquid. It is then to be taken from the fire, and poured clear off, taking care to keep back the litharge and the thick part which depoſits itſelf at the bottom. During the boiling we ought to ſtir the liquid from time to time, in order to aid the precipitation of the litharge; but

it ought not to be stirred constantly, for fear that the finer particles of the litharge might mix with the oil, and render the varnish too thick.

Preparation of the Amber Varnish.

Take one part of amber, torrefied or melted, according to the process above described, three parts of varnish of linseed oil, and four parts of oil of turpentine. The amber and the linseed oil varnish ought to be mixed together in a pan, so as to fill only about one-third of its capacity. Place the mixture over a slow fire till the amber be dissolved, which may be known by its frothing up. One ought to have a vessel at hand, for receiving what may run over in case of accident, in order to avoid any waste of the amber. We might also use for this purpose a pan, made after the plan of the boiler invented, in the year 1799, by Mr. Smith, of Philadelphia, for the purpose of preventing the running over of boiling liquids, and which is provided with a double rim, to which are fixed sponges, moistened with water, the contact of which refrigerates the liquid that rises up to them. When the amber is dissolved, the pan is taken off the fire; and when the mixture has cooled, we add to it the essence of turpentine, stirring it constantly whilst we are pouring it out. We then leave the whole to stand quiet for some time, in order that the gross and undissolved particles may subside to the bottom; after which the varnish is poured clear off, strained through linen or fine cloth, and put into bottles.

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In boiling the varniſh, we ought to take care neither to let it overflow nor take fire; if we neglect the precautions that have juſt been pointed out, and the accident ſhould unfortunately take place, we ſhould not attempt to extinguiſh the flames with water; for were we to do that, the varniſh would be forcibly thrown out of the veſſel, and would burn the imprudent operator; nay, might even ſet fire to the building itſelf in which the operation was performed. The ſafeſt method is, to extinguiſh the fire by means of a lid of wood or iron, which ought always to be kept in readineſs for fear of accidents.

The purpoſed object was to obtain a dye, which might perfectly imitate mahogany, and which would keep for as great a length of time as poſſible. Theſe varniſhes, as well as the dyes which we are about to deſcribe, have been tried upon various ſpecies of wood; namely, the elm, the oak, the white beech, the red beech, the pear, the hawthorn, the aſh, the alder, the birch, the pine, and the maple. Amongſt theſe woods, the maple, the birch, and the white beech, when tinged with a ſolution of iron, had the greateſt reſemblance to mahogany. The appearance of the other woods was greatly varied according to the differences of their natural colours and veins, their different degrees of poroſity, and the facility with which they imbibed the colouring ſubſtance.

The Iron Dye.

Take eight parts of iron filings, and thirty two of aqua fortis. The nitric acid (or aqua fortis) ſhould previouſly be diluted with ſixteen parts of water, in a veſſel of ſtone-ware, before we add the iron-filings. We ſhould then ſtir this mixture with a wooden ſpatula. This preparation ought to be made under a chimney, on account of the efferveſcence and diſengagement of inflammable air (hydrogene gas) which takes place. The veſſel which we uſe ought to be twice as large, at leaſt, as the quantity of the mixture would fill, in order that it may be prevented from overflowing during the efferveſcence. When the iron has been diſſolved, the mixture has acquired a yellowiſh brown colour, and as ſoon as it has cooled, let it be put into an open bottle, and placed upon the ſand-bath; and there let it remain for the ſpace of eight and forty hours, taking care frequently to ſhake the bottle during that time. When the depoſition has taken place, the ſolution ſhould be poured into flaſks, which ought to be carefully corked: it will then be fit for uſe.

If this preparation has been made with the requiſite care, we ſhall obtain a ſolution of a yellowiſh colour, which is fit for colouring different kinds of wood. If we have added too much water, or if the aqua fortis has been too weak, a deep brown colour is produced; in which caſe, we muſt add a quantity of nitric acid, till the yellow ſhade appears.

This dye may be applied to every kind of wood, except the oak, which, as ſoon as it is applied to it,

it, becomes entirely black; it alſo communicates to other kinds of wood different colours, according as it is applied in a larger or ſmaller quantity. The moſt common ſhades are the yellow-brown, and the deep-brown, with ſtreaks or ſpots of a browniſh red.

The experience of four years has demonſtrated the durability of this kind of dye; it reſiſts the action of the air, of the light, and even of the direct rays of the ſun, without undergoing any alteration. M. Nyſtrom has expoſed ſpecimens of wood, ſtained in this manner, in the moſt diſadvantageous ſituations, without their colours having been perceptibly affected.

The Dye of Fernambouc Wood.

Take eight parts of Fernambouc wood, four of alum, and four of red ochre pulveriſed. Pour water upon this mixture, and let it infuſe for the ſpace of twenty-four hours; then reduce it to a quarter of the quantity, by boiling, after which, ſtrain it through a piece of fine linen, and put the liquid into bottles, to be uſed as you may have occaſion for it.

When we make uſe of theſe dyes, we may plunge the pieces of wood into them, ſo that they may penetrate into them on all ſides. If we take one part of the iron dye, and dilute it again with three parts of water; if we then pour it upon ſeveral pieces of wood, which are to be kept by force under the fluid; and finally, if we depoſit this preparation in a warm chamber, the wood will in a ſhort time be penetrated by the liquor to the depth

depth of a quarter of an inch, and in some parts the liquid will penetrate still deeper.

It is to be observed, that the dyeing liquid should be more or less diluted with water, according as the natural colour of the wood is more or less deep, or charged with gallic acid. The pieces of wood must be frequently turned in order that all their surfaces may be equally exposed to the action of the dye, and acquire an uniform tinge. The same process may also be used with the Fernambouc dye. This method, however, is only applicable to pieces of wood of certain dimensions; for dyeing large pieces a different one must be adopted.

In order to dye the white woods with the two compositions already described, the piece of wood ought to be rubbed, five different times, with a sponge dipped in the iron-dye, till it has acquired a mahogany colour. During this application, we must remember frequently to shake the liquor, as the oxyde of iron always falls to the bottom. It is also necessary that we should suffer the wood to dry, after each application, before we proceed to the next. When the wood has properly dried, it must be rubbed once or twice with linseed oil, always letting it dry after each application. The more the wood is imbued with the linseed oil, the more mellow are the colours. Another advantage which results from this process is, that the wood does not absorb so much of the amber-varnish, which is expensive, and which is thus compelled to remain upon the surface to which it gives a gloss.

The wood being prepared in this manner, it is done over with a uniform coat of amber-varnish, by

by paſſing once or twice over it a ſponge dipped in this varniſh, till the ſurface has acquired a very bright gloſs. If the wood has been well imbued with linſeed oil, a ſingle coating of varniſh will be ſufficient; though ſome articles of furniture, ſuch as bedſteads, cheſts of drawers, chairs, &c. which are expoſed to conſtant uſe, and to conſiderable friction,. require the application of ſeveral coatings, between each of which the varniſh ſhould be ſuffered to dry.

When the wood has been varniſhed, any inequalities or ruggedneſſes that may remain upon it are removed, after the varniſh has completely dried, by poliſhing it with reeds, after which one more coating of varniſh is applied, to cover the parts that have been laid bare. For applying the varniſh, a ſponge has been found to be by far the beſt inſtrument. It covers the wood in a more uniform manner than the painter's bruſh, which in general forms ſtreaks in the coating, and frequently leaves hairs in it, which afterwards ſeparate themſelves from the ſurface of the wood. The varniſhing-ſponge ought, as ſoon as we have done uſing it, to be put into a bottle, to preſerve it from the contact of the air; for, without this precaution, it would grow hard, and crack, ſo as to become unfit for uſe.

In applying the Fernambouc dye, we may proceed according to the ſame method. When this dye is applied to the wood of the birch, or knotty alder, undulated ſtreaks are formed upon the ſurface, the dye running in the direction of the fibres. The ſame effect takes place with the wood of the pine and red fir; for the reſinous veins do not attract the dye ſo ſtrongly as the

reſt

reft of the wood; but this circumftance, inftead of being a difadvantage, frequently adds very much to the beauty of the wood.

Thefe varnifhes have been employed by M. Nyftrom, after the manner that we have defcribed, for all kinds of furniture, and with great fuccefs. They have been ufed for the fpace of nearly three years, and no change has as yet been obferved in their appearance. When the varnifh has become dry and hard, it refifts the effects of friction and of boiling water; neither is it fubject to lofe its glofs by age, provided it be not fcratched by any hard fubftance. If ink, or any other coloured liquid, fhould drop upon it, it does not penetrate, but may be removed by wafhing the furface of the varnifh with warm water. This advantage might alone be fufficient to recommend the application of this varnifh to mahogany itfelf. It poffeffes the property of hardening the furface of foft woods. Its ufe is not attended with much expence, eight ounces being fufficient for varnifhing a common table — a card table, for inftance. If ftreaks form in it, the fpots that have been injured may be repaired with a new coating of varnifh; finally, by varnifhing furniture in this manner every four or five years, we may make it appear perpetually new.

Tables, and other large pieces of furniture, made of ftained wood, which require a high degree of polifh, may be finifhed with pumice-ftone: thofe of the moft even grain and the fmootheft furface are to be preferred. The white, or foft woods, generally puff up when the varnifh is applied, and thus lofe their polifh; it is therefore

fore very neceſſary that they ſhould previouſly be rubbed with pumice-ſtone.

In treating of amber-varniſh, it might perhaps not be uſeleſs to obſerve, that it may be applied to gilding without producing any conſiderable change in its luſtre, particularly if applied in very thin layers, and in an uniform manner. It is eaſy to conceive the advantage of an application, which enables us to clean gilt frames, or other furniture, by waſhing them with ſpirit of wine, or even with ſoap and water, without injury to their brilliancy. It cannot, however, be uſed for covering falſe gilding, as this is attacked and diſcoloured by the varniſh. We ſhall ſtill remark, that it may be uſed for varniſhing all ſorts of oil colours, except the blue, to which it gives a greeniſh tinge. This varniſh poſſeſſes the advantage, that it never cracks, like thoſe which are prepared with gum-lack and ſpirit of wine. A prodigious quantity of amber grows on the coaſts of the Baltic, from whence it might eaſily be obtained.

LXVII. *Obſervations on Vinegar.* By *Citizen* PARMENTIER.

FROM THE *ANNALES DE CHIMIE.*

VINEGAR, conſidered with a view to its œconomical, pharmaceutical, and chemical uſes, is at preſent of ſuch general utility, that it may be looked upon as an article of the firſt neceſſity.

Simple as the proceſs by which it is prepared may appear to be, it is by no means unattended with difficulty; but it is principally when we wiſh to obtain this acid in its greateſt perfection, that we find reaſon to acknowledge how much its qualities may be influenced by art, and how neceſſary it conſequently is, that we ſhould make ourſelves well acquainted with what happens during the proceſs of acetous fermentation, in order that we may be enabled to direct its progreſs, and calculate its product.

Influenced by theſe motives, the authors of the tenth and laſt volume of the *Cours complet d'Agriculture*, conceived that an Eſſay on Vinegar, as forming a natural appendix to that which Chaptal had publiſhed on the manufacture of wine, would afford their readers an inſight into the different changes which are experienced by liquors ſuſceptible of the vinous and acetous fermentation, and thus enable them the better to appreciate the comparative worth of the proceſſes followed in the common routine of manufacture, and thoſe founded upon practice, enlightened by theory.

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It is to citizen Parmentier, one of the fellow-labourers of Roſier in the *Cours d'Agriculture,* that we are indebted for the Eſſay on Vinegar, of which we are about to preſent our readers with an extract.

Before entering upon his ſubject, the author has thought fit to inform us, that it is not the art of the vinegar-manufacturer that he means to publiſh; this art, he ſays, is fully explained in the Collection of Arts and Manufactures, printed in 4to, at Neufchâtel; but as the very copious and intereſting details which it contains would be out of their place in a ſimple eſſay, which ought only to exhibit general views and the principal facts, he has thought it better to dwell upon the formation, preparation, preſervation, and properties, of the different ſorts of vinegar moſt uſed in Europe, and to compriſe, within a ſmall treatiſe, all the advantages which may accrue from the employment of this acid to the arts, to pharmacy, and to œconomy.

In order to give a greater perſpicuity to his treatiſe, Citizen Parmentier has divided it into ſeveral paragraphs: in the firſt, he preſents us with general reflections on the theory of acetification.

It appears that the ancients had but very confuſed ideas concerning the cauſe of the converſion of wine into vinegar. And how, in fact, could they form any accurate notions upon this ſubject, when we know that they were far from being acquainted with the nature of the principles which act ſo important a part in the proceſs of acetous fermentation.

We muſt acknowledge, that it is only ſince the gaſes and their properties have been diſco-

vered, that we have learnt to reaſon with greater preciſion concerning this ſpecies of fermentation; and it is alſo particularly ſince we have carefully obſerved all that happens during its different ſtages, that we have ſucceeded in eſtabliſhing a theory, which lays the greater claim to adoption, as it is founded upon facts, the reality of which can no longer be called in queſtion.

At the preſent day it cannot be diſputed that oxygene, hydrogene, and carbone, are the principal agents that contribute to the formation of vinegar. Theſe three principles, which are alſo found in the greater part of the other vegetable acids, cannot form vinegar, unleſs when combined in proportions ſo conſtant and ſo rigorouſly determined, that be they varied never ſo little, they immediately afford new products.

It is to this cauſe that we ought to attribute the frequent changes that take place in vinegar when the requiſite precautions are not taken for maintaining, between the three principles which we have juſt mentioned, that ſpecies of equilibrium upon which the exiſtence of this acid depends.

If the acetous fermentation exhibits phænomena analogous to thoſe which accompany the vinous fermentation, it can alſo not be denied, that there are certain phænomena peculiar to each of theſe kinds of fermentation, and ſo open to obſervation, that it is very eaſy to diſtinguiſh them.

For example, it is very certain that, during the courſe of vinous fermentation, there conſtantly takes place an extrication of elaſtic fluids, which are formed at the expence of the liquid itſelf, which is ſubjected to the fermentation; whilſt, in the acetous fermentation, the produc-

tion

tion and diſengagement of aëriform fluids take place only during certain ſtages of the proceſs, and that at one period during its courſe a very ſenſible abſorption may be obſerved.

Roſier, the firſt who has inſiſted upon this fact, conceived that it was atmoſpherical air that was abſorbed in this caſe; but it has ſince been proved, to demonſtration, that the oxygene contained in the atmoſpherical air is the only principle that enters into combination with the other principles of the fermenting liquid, and that it eſſentially contributes to the formation of the acid which conſtitutes vinegar.

This being aſcertained, we cannot be at a loſs what to think of the aſſertion of Becher, who pretends that he has converted wine into very ſtrong vinegar, by merely letting it digeſt for a long time over the fire, in a bottle hermetically ſealed. If he really has ſucceeded, it could only be owing to his having operated upon a very ſmall quantity of wine contained in a ſpacious veſſel.

Amongſt the number of operations formerly practiſed for converting wine into vinegar, many were uſeleſs or defective, the greater part did not anſwer the purpoſe for which they were intended; and it was undoubtedly for this reaſon that the neceſſity was felt of ſimplifying them, and ſubſtituting other more advantageous ones. *Cartheuſer*, *Boerhaave*, *Demachy*, *Guyton-Morveau*, *Prozet*, *&c.* *&c.* have principally employed themſelves on this ſubject. By pointing out the improvements which ought to be adopted, and the only operations which were proper to be employed, they rendered almoſt univerſally known the art of making vinegar,

vinegar, which was formerly practiſed only by a few individuals, whoſe proceſſes were always concealed under a veil of myſtery.

It muſt however be admitted, that the improvements propoſed by the above-mentioned learned men, were not ſo generally adopted as was to have been wiſhed. In many of the departments of France the ancient proceſſes are ſtill in uſe, and it is undoubtedly to the careleſſneſs which exiſts with reſpect to this ſubject, that we have to aſcribe the defective vinegars often met with in commerce, the quality of which is generally ſo bad as to render them altogether uſeleſs.

In the ſecond paragraph, Citizen Parmentier points out the moſt general conditions requiſite for the formation of good vinegar.

Theſe are four in number:

1. The acceſs of the external air into the veſſel which contains the liquid intended to become acid.

2. A temperature higher than that of the atmoſphere.

3. The addition of ſubſtances which perform the office of a ferment.

4. The preſence of a certain quantity of alkali.

The acceſs of the atmoſpherical air is ſo indiſpenſably neceſſary to the formation of vinegar, that this acid cannot be produced without it. What has been ſaid in an earlier part of this eſſay, concerning the manner in which this aëriform fluid acts during the acetous fermentation, is ſo well known at the preſent day, that it ſeems unneceſſary to revert to it. Neither can the neceſſity of the concurrence of heat be called in queſtion; but the heat ought to be moderate. In general

general it ought not to exceed 18,20 degrees of Reaumur's thermometer; if a higher temperature is applied, it injures the quality of the product.

The following is a ſtriking inſtance of the inconvenience which reſults from employing a higher degree of temperature than that which we have indicated.—A vinegar manufacturer of Orleans, conceiving that the higher he raiſed the temperature in his workſhop, the ſtronger his vinegar would turn out, heated his ſtove to ſuch a degree as to raiſe the temperature of the atmoſphere to 30°; but, upon examining the vinegar which he had obtained, he found, to his no ſmall ſurpriſe, that it was not only very weak, but alſo of a bad quality. He then applied to Citizen Prozet, who acquainted him with the proper degree of temperature, and ſince that time he has always obtained vinegar of very good quality.

But even though ſo concluſive an experiment ſhould not be thought to prove the neceſſity of moderating the heat in the places where vinegar is manufactured, we need only reflect for a moment upon what happens in the proceſs of acetous fermentation, to be convinced that if it be neceſſary to determine the formation of the different combinations from which, in their turn, an acid is to be produced, it is alſo neceſſary that when theſe combinations have once been produced, we ſhould prevent their ſeparating from the liquid in which they are contained: now the ſureſt means of preſerving them is to avoid a too high degree of temperature, and it is preciſely for this reaſon that pains have been taken to aſcertain the degree at which we ought to deſiſt from augmenting

menting the temperature, which has been fixed at between 18° or 20° of Reaumur's thermometer.

The addition of ſubſtances proper for forming ferments, is a condition ſo indiſpenſably neceſſary to the production of the acetous fermentation, that it would be difficult to prove that it can be omitted without detriment. It is well known that the great art of the manufacturer of vinegar conſiſts in eſtabliſhing, at one and the ſame time, in the whole maſs of vinous fluid, an internal motion, which agitates its conſtituent principles, compelling them to ſeparate from each other, and afterwards reunite into combinations different from thoſe in which they previouſly exiſted. It would be in vain for us to expect to obtain ſuch a motion by leaving the wine to itſelf; a part of this fluid might indeed become at length acidified, but before the whole could be completely ſo, it would require a great length of time, and then the firſt portions of acid that had been formed would be very near to a ſtate of decompoſition. Be that as it may, the choice of the ſubſtances proper for forming ferments is by no means a matter of indifference, and this choice ought always to be determined according to the quality of the fluid upon which one operates. The author enters into details relative to this ſubject, which are the more intereſting as being the reſult of experience and obſervation.

Finally, the obligation impoſed upon us, as the fourth condition, to employ wines of good quality if we wiſh to obtain excellent vinegar, is naturally deduced from the ſtate of the conſtituent parts of theſe wines; it is eaſily conceived, that the more they poſſeſs of a ſpecies of perfection, the more they

they will alſo influence that of the new product which is about to be formed. Moreover, in this caſe experience entirely accords with theory, for it is univerſally admitted that the beſt kinds of vinegar are thoſe that have been manufactured from generous wines.

The third paragraph preſents us with a deſcription of the operations requiſite for the manufacture of different kinds of vinegar.

The author has not contented himſelf with deſcribing the proceſſes for making wine-vinegars; but be has alſo deſcribed thoſe employed for obtaining the vinegars of cyder, of perry, of malt-liquors, of the bran of wheat, with ſuch preciſion, that whoever may wiſh to repeat them may be ſpared the trouble of making any trials that may prove unſucceſsful.

In the ſame paragraph, the author makes mention of ſeveral other acids, which, in certain places, are employed as ſubſtitutes for ordinary vinegar.

Such are verjuice, the acid of milk, that of honey, &c. &c.; though theſe acids, chemically conſidered, are ſomewhat different from thoſe furniſhed by wine, it is no leſs true that they afford great reſources, and that in ſome departments of the Republic where they are principally conſumed, they are in daily uſe, without producing any bad effects upon the health of the inhabitants.

The fourth paragraph is intituled: *Of the Acids uſed as Subſtitutes for Vinegar.*

The greater part of the vegetable acids ſtands in the ſame predicament with thoſe that have been treated of in the preceding paragraphs. Though eſſentially different from wine-vinegar, they have, in certain reſpects, ſo great an analogy with the latter,

latter, that people have not heſitated to make uſe of them in its ſtead. It is for this purpoſe, undoubtedly, that the juice of the currant, barberry, &c. are expreſſly ſubjected to the acetous fermentation. The liquors procured by theſe means afford very uſeful ſubſtitutes for vinegar; but they have the diſadvantage that they will not keep. In general they ſoon become covered with mould, ſoon after they have been prepared, and at length are entirely decompoſed.

Before the revolution, vinegar formed a very important article of commerce with certain nations; the Dutch in particular carried on a very conſiderable traffic with it. The vinegars which they manufactured were exported to their colonial poſſeſſions, and, as they were of good quality, they bore long voyages without ſpoiling.

Citizen Parmentier imagines that this branch of commerce might alſo become very productive in the *Department de la Seine*, and that the inhabitants, by their commercial genius, might eaſily increaſe their exports, and thus add to the great advantages which they derive from their geographical poſition.

The manner of preſerving vinegar forms the ſubject of the fifth paragraph.

Vinegar, be it ever ſo well prepared, is ſubject to the lot of all compound fluids; namely, that at the end of a certain period it undergoes ſenſible alterations.

There are however means by which theſe alterations may be retarded; they conſiſt in defending the vinegar againſt the influence of the external air, by keeping it in proper veſſels, well cloſed and placed in a cool ſituation.

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Its alteration may alſo be retarded by depriving it of a portion of the water which it contains; for which purpoſe nothing more is neceſſary than to let it boil for an inſtant; but the veſſels which are employed in this operation muſt not be made of copper.

The proceſs propoſed by Scheele, with a ſimilar intention, is very ſimple: it conſiſts in filling with this acid glaſs veſſels, which are placed in boilers full of water. The water is then made to boil for a full quarter of an hour, after which the vinegar is taken out, and may then be kept for ſeveral years without undergoing any alteration.

Diſtillation has alſo been recommended as a means of preſerving vinegar; but, beſides that it is a tedious and difficult proceſs, it deprives the acid of the agreeable ſmell and taſte peculiar to it in its natural ſtate, and which one always wiſhes to find in it.

In fact, diſtilled vinegar is not ſuſceptible of alteration, and it is partly on this account, and partly alſo becauſe it contains no ſubſtance foreign from its compoſition, that it is reſerved for chemical operations, and employed in preference to the other in many pharmaceutical preparations.

The ſame is the caſe with vinegar that has been concentrated by freezing. The acid, by this ſimple proceſs, becomes much ſtronger, and may be kept for a greater length of time; but it acquires an empyreumatic ſmell and taſte, which render it unfit for being employed as a ſeaſoning for aliments. This vinegar, like the diſtilled, is almoſt ſolely employed in chemical laboratories.

 Finally,

Finally, ſea-ſalt, or muriate of ſoda, which ſome have recommended to be added to vinegar, as being able to preſerve this acid, ſometimes ſucceeds well enough; however it is not without its inconveniences; for the vinegars, that contain this ſaline ſubſtance, grow turbid, and at length loſe their primitive qualities.

However, this proceſs ought not to be neglected, and though it may not ſucceed quite ſo perfectly as we could wiſh, we may ſtill employ it in certain caſes with advantage, eſpecially if the quantity of ſalt added to the vinegar be not too conſiderable.

The ſigns by which we may diſcover whether the vinegar be good, adulterated, or ſpoiled, form the ſubject of the ſixth paragraph.

Nothing is more common than to meet, in commerce, with vinegars of bad quality. Two cauſes principally contribute to their being in that ſtate: the firſt, that they have been manufactured with weak wines, or ſuch as are already ſpoiled; the ſecond, that they have either been mixed with acrid ſubſtances, ſuch as pimento, &c. or mineral acids, ſuch as the ſulphuric and muriatic, have been added to them.

When the buyer, unacquainted with the fraud, taſtes theſe kinds of vinegar, he imagines that the effect, which they produce upon his palate, is to be aſcribed to the ſtrength of the vinegar, and frequently that alone is ſufficient to make him conclude that the vinegar is of good quality. How groſſly he is miſtaken is very evident.

However, nothing is more eaſy than to detect ſuch a fraud; it being ſufficient to ſaturate a given quantity of potaſh with the vinegar that is

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ſuſpected of being adulterated, and to compare the quantity of vinegar that we have been obliged to employ before we could obtain a complete ſaturation with that conſumed in a ſimilar experiment made with vinegar, the good quality of which we are aſſured of.

We ought afterwards to evaporate a portion of this vinegar till a pellicle is formed upon it, and examine if, when it has cooled, it has not depoſited ſome ſaline precipitate. If it has, the form of the cryſtals will ſhew us what ſpecies of acid has been uſed for adulterating the vinegar.

As to the acrid vegetable ſubſtances that may have been mixed with it, they will readily be recognized by their taſte, which will be altogether different from that of vinegar, and which will become the more perceptible the more the acid has been concentrated by evaporation.

In general, vinegar that has not been adulterated, or which has not been ſpoiled by an incipient decompoſition, is readily known by its acid taſte, its tranſparency, and its agreeable ſmell, a ſmell which becomes ſtill more developed when we rub ſome of the vinegar between the hands.

In the ſeventh and eighth paragraphs, the author treats of the uſe of vinegar in preſerving freſh meat, fruits, and eſculent vegetables.

Every one is acquainted with the great utility of vinegar in preſerving fleſh from the change which it ſpeedily undergoes, particularly during the heat of the ſummer; it is alſo known that this acid, which is daily employed in our kitchens, has the property of giving to certain kinds of fleſh meat an agreeable taſte, and rendering them

 more

more tender, and consequently more fit to be eaten; but, in order to produce these effects, it is necessary that the vinegar should be of good quality; otherwise the result would be directly contrary to that which we hoped to obtain.

As to the preservation of fruits, and esculent vegetables in vinegar, it is a practice almost universally in use; but in this case also it is necessary that the vinegar should be good; otherwise the fruits become soft, and at length unfit to be eaten.

The aromatic vinegars form the subject of the ninth paragraph.

The author dwells, in this article, upon the property which vinegar possesses of imbibing the aroma of plants; he mentions several aromatic vinegars, which are the most in use, both for the table and the toilet, and he points out the precautions that must be taken in order to make them keep for a long time. But this acid also imbibes the more active properties of the vegetables, and it is upon this that the art of making medicated vinegars is founded; the method formerly practised with the intention of forming such vinegars, by letting the medicinal plants ferment together with the wine, is now known to be grounded in an error.

In the tenth and last paragraph, Citizen Parmentier treats of the medicinal and œconomical uses of the vinegar itself: he shews the great utility of this acid in putrid and contagious diseases, whether administered internally, or applied externally. He quotes, under this head, the regulations by which the marine of France commands the captains of ships not to put to sea without

without a quantity of vinegar ſufficient for waſhing their decks, cabins, &c. at leaſt once every five days. He proves that it is frequently owing to a ſimilar uſe of vinegar that crews have been preſerved from the diſeaſes prevalent in fleets, and that on this account alone more attention than ever ought to be paid to the execution of the regulations mentioned above.

Finally, the author dwells upon the utility of vinegar in the arts, and the impoſſibility of ſupplying its place by any other known acid.

From the expoſition which we have given, it will be eaſy to ſee that the Treatiſe on Vinegar in the *Cours complet d'Agriculture*, fulfils all the conditions that were to be deſired in ſuch a treatiſe. If Citizen Parmentier has not thought it neceſſary to treat his ſubject with all the detail of which it was ſuſceptible, it will at leaſt be admitted, that he has dwelt upon thoſe points which it was moſt eſſential to know, and that in this reſpect he has completely fulfilled the views propoſed to themſelves by the authors of the work for which this article was intended. We therefore have no doubt that the labours of Citizen Parmentier will be favourably received, and that, as we have already ſaid, they will form a worthy counterpart to the article on wine by Citizen Chaptal, which, according to the avowal of all who have read and ſtudied it, deſerves to be ranked amongſt the beſt productions of that illuſtrious chemiſt.

LXVIII. *Of the Manufacture of Soap.*

(Concluded from Page 344.)

ARTICLE II.

Of the Manufacture of Soft Soaps.

THE work-ſhop of the manufacturer of ſoft ſoaps ought to be furniſhed with the ſame utenſils which are required in the manufactories of hard ſoaps. The lyes of potaſh are prepared in the ſame manner, and with the ſame attention, as thoſe of ſoda. They will have all the cauſticity that is required, if we take eighty pounds of lime to a hundred pounds of potaſh. This quantity of potaſh is in general ſufficient for converting into ſoap a hundred and ſixty pounds of oil.

The manufacturer ought to manage his boiler with all the precautions preſcribed for the manufacture of hard ſoap. The whole of the lye which has been uſed ought to remain in combination with the ſoap; it is therefore neceſſary that it ſhould not be ſuffered to ſeparate from the paſte, and that the latter ſhould be prevented from clotting. The paſte is reckoned to be ſufficiently boiled, when after cooling it is found to be perfectly united, and of a ſoft clammy conſiſtence.

In manufacturing this ſpecies of ſoap, care ſhould be taken not to make uſe of any ſoda or ſea-ſalt. Theſe ſubſtances, as we have ſeen in the firſt ſection, tend to give a hardneſs to the ſoap made with potaſh, and would in fact render it hard if employed in ſufficient quantity.

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The soft soaps are either green or black: when oil of hemp-seed is employed alone, we obtain them of a green colour without making any further addition; if we use oil of colza, we obtain yellow soap, the colour of which is changed into green, by adding a small quantity of indigo during the boiling. When we have used any colourless oil, such as that of lint-seed, we may give a green colour to the soap by the addition of a yellow and a blue pigment; namely, curcuma for the yellow, and indigo for the blue; but as these different oils are usually employed mixed together, the manufacturers are in the habit of adding, during the boiling, a mixture of curcuma and indigo when they wish to have green soaps; and when black soaps are wanted of them, they colour them by adding, during the boiling, a small quantity of sulphate of iron and decoction of gall-nuts.

§ II. *Of the domestic Means of obtaining Substitutes for the Soap of Commerce.*

The domestic manufacture of soap differs from that which has just been described only in the extent of the apparatus, as we shall see hereafter.

It is to Citizen Chaptal that we are indebted for the idea of composing saponaceous liquors, as substitutes for those solutions of soap which are in daily use. His processes are very simple, and require no other materials and utensils than such as may always be procured without difficulty.

Article I. *Of the Manufacture of Soap in ſmall Quantities.*

It is neceſſary that firſt of all the requiſite materials and utenſils ſhould be procured: the latter are but few in number. They conſiſt of, 1, a ſmall tub of white wood, nine inches in width, and as many in height. This tub ſhould be perforated near the bottom; its uſe is for mixing the lyes. (Were it made of oak, it would colour the lyes.) 2. A ſmall copper baſin, with a round bottom, a foot in diameter, and ſeven or eight inches in depth; or, where this cannot be procured, an iron pot, or earthen veſſel that can bear the fire, may be uſed. This veſſel is intended for boiling the ſoap. 3. A ſmall box without a lid, or a mould for receiving the ſoap when it is boiled. It ought to be ten inches in length, four in breadth, and ſix in depth; one of the long ſides ſhould have a hinge, and be held faſt by means of hooks, in order that the box may be readily opened for the purpoſe of taking out the ſoap. 4. For this ſmall manufacture are finally required a ſkimmer, a ſpatula of white wood, and one or two earthen pans.

As to the materials neceſſary for manufacturing hard ſoap, we require, 1, ſome good ſoda; 2, lime; 3, a ſmall quantity of ſea-ſalt; and, 4, olive oil.

Of the Means of preparing the Lyes.

In order to convert into ſoap three pounds of olive oil, for example, we take three pounds of ſoda, and one pound of lime. We firſt pulverize

rize the ſoda, after which we moiſten the lime with a ſmall quantity of water, in order to ſlake it; and after it has completely crumbled down, we mix it with the ſoda, and put this mixture into the tub, having previouſly ſpread a piece of canvas at the bottom; we ſhould alſo carefully cloſe the hole at the bottom of the tub; after which we pour upon the materials a quantity of water ſufficient to ſoak it well through, and riſe above it in the veſſel, to the height of about three finger-breadths. We then ſtir it well with a ſtick, and, having ſuffered it to ſtand for ſome hours, we open the hole, in order to let the lye run off, which is collected and kept by itſelf. This is the firſt lye. We again put freſh water into the tub, ſtir the materials with a ſtick, let them ſtand for ſome hours, and then draw off the ſecond lye, which is alſo kept ſeparate: the third lye is obtained in the ſame manner, by pouring freſh water upon the remainder of the ſoda, which will now have been ſuffieiently exhauſted of its ſaline particles.

Article II. *Of the Compoſition of ſaponaceous Liquors.*

Firſt Method.

Take the aſhes produced by the combuſtion of wood, but not float-wood, and make a lye, according to the uſual proceſs, by mixing with the aſhes one or two handfulls of quick-lime, well pounded, or recently ſlaked with water: let the water of the lye ſtand to purify till all the foreign ſubſtances which it may contain either ſink to the

 bottom

bottom or ſwim at the top; then pour it into another veſſel, and put it by for uſe.

When we wiſh to make uſe of this lye, we pour any quantity of it upon a thirtieth or fortieth of its weight of oil; whereby we immediately produce a liquid as white as milk, which, when ſtrongly agitated, forms a lather like good ſoap-water: we pour this liquor into a tub, and dilute it with a ſmaller or larger quantity of hot water, after which the ſtuffs which we intend to waſh are ſoaked, rubbed, and wrung in it, as in ordinary waſhing.

Obſervations.

1. It is of importance, that we ſhould not prepare the lye till the moment when we intend to uſe it; for, by being kept in open veſſels, its virtues are diminiſhed and its properties changed.

2. Freſh aſhes are preferable to others; for, when they are old, and have been expoſed to the air, they are found no more to poſſeſs the ſame properties; in which caſe, if we wiſh to make uſe of them, we muſt mix with them a larger quantity of quick-lime.

3. The aſhes obtained from hard wood are the beſt; thoſe yielded by float-wood cannot be employed with the ſame advantage.

4. Fat thick oils ſhould be preferred for this operation; the finer oils cannot be uſed for the ſame purpoſe: thoſe which we ought to employ are the oils termed in commerce Dyer's Oils, &c. (*huiles de teintures, huiles d'enfer.*)

5. When the oil is ſtinking, it communicates a ſmell to the linen waſhed in the liquor; but it may be freed from this ſmell by ſteeping it again into

into a pure and pretty ſtrong lye, and letting it remain there for ſome time: the ſmell is generally deſtroyed by merely drying the cloth.

6. When the mixture of the oil and lye is of a yellowiſh colour, we muſt dilute the lye with water.

7. When the oil riſes in the lye, and ſwims at the top of the liquor, forming ſmall drops on its ſurface, it ſhews that the oil is not proper for the purpoſe, that it is not ſufficiently thick, or that the lye is either too ſtrong, or does not poſſeſs ſufficient cauſticity.

8. In order that the lime may not loſe its properties, and that we may always have ſome at hand in caſe we ſhould want it, we may pound it, and preſerve it in bottles well dried and corked.

Second Method.

The float-wood, which is uſed in ſeveral of the departments of the Republic, produces aſhes which have but little of an alkaline quality, and which conſequently are little fit for making lyes; in ſuch countries their place may be ſupplied by ſoda or potaſh, in the following manner:

Take a quantity of ſoda, and break it into ſmall pieces, about the ſize of a hazel-nut; put theſe into a veſſel, and pour upon them twenty times their weight of water; let them remain in the water till this acquires a ſlightly ſaline taſte. Put a quantity of oil into an earthen pot, and pour upon it about forty parts of ſoda-lye to one of oil; upon which the liquor will become white, and is to be uſed like the ſaponaceous liquors, which are diluted with a quantity of pure water, more

or

or leſs conſiderable, according to their ſtrength, and the purpoſes to which they are to be applied. In the place of ſoda we may ſubſtitute potaſh, in which caſe we mix with it a ſmall quantity of pounded quick-lime.

Obſervations.

1. The ſodas of Alicante and Carthagena may be uſed without any mixture of lime; but the inferior ſodas of our climates require to be mixed with a quantity of lime, more or leſs conſiderable, according to their different degrees of ſtrength and purity.

2. When ſoda has once effloreſced, or been melted, whatever its quality may be, it cannot be uſed except with the aid of lime.

3. If the ſoda is too ſtrong, the oil ſwims at the top; in which caſe it muſt be diluted with water.

4. Fat oils muſt always be employed; the fine light oils cannot be uſed for this purpoſe.

5. When the ſaponaceous liquor is of an oily nature, and communicates this quality to the cloths that are ſteeped in it, theſe may be cleaned of the greaſe, by paſſing them through pure ſoda-water, which ſhould be ſlightly heated, in order to augment its effect.

6. When we have conſumed the whole of our ſoda-water, we may pour upon the remainder of the ſoda a freſh quantity of water, which will become impregnated with new ſaline particles; and thus the ſame quantity of ſoda may ſerve for ſeveral ſucceſſive operations.

Section III.

In this section we propose to point out the differences of quality that result from the use of different fundamental substances in the manufacture of soap, and the artifices which are practised by dishonest dealers for the purpose of defrauding the consumer. We shall likewise treat of soaps manufactured in the cold way.

§ I. *Of the Differences of Quality that result from the use of different fundamental Substances in the Manufacture of Soap.*

We have seen, in the first section, how the quality of the soap is modified by the choice of the alkali: we have there remarked, that potash affords only soft soaps; and that, in order to obtain hard soap, we must always directly or indirectly make use of soda. It would be useless to dilate more upon this point; we shall therefore proceed to the consideration of the different species of oils. The soaps of which we shall treat in the sequel of this paragraph are all such as have soda for their base.

I. *Oil of Olives. Oil of Sweet Almonds.*

The soaps manufactured at Marseilles, and in the neighbouring parts of France, are esteemed the best that are to be met with in commerce: they owe this superiority to the oil of olives, which is exclusively employed in their composition; no species

ſpecies of oil is more eaſily converted into ſoap, nor yields hard ſoaps of a better quality.

Two ſpecies of oil are extracted from the olive; the one of which is produced by the firſt preſſing, and is termed virgin oil *(huile vierge)*; the other, which is called *huile commune*, *huile d'enfer*, is ſeparated from the fruit by a ſecond operation. The manufacturers of ſoap make uſe only of the common oil, which is eaſily converted into ſoap, and which being acrid and thick, and conſequently unfit for being uſed, like the finer oil, for the purpoſes of cookery, is neceſſarily cheaper than the other.

The fine oil is never uſed in the manufacture of ſoap, unleſs when it has become thick and rancid, and in general when age, or any other circumſtance, has deprived it of that ſuperiority which it naturally poſſeſſes over the common oil.

The *Oil of Sweet Almonds* affords a ſoap of a very white colour, of an agreeable ſmell, and of a ſufficiently ſolid conſiſtence, though leſs ſo than that of the ſoap manufactured with the oil of olives.

This ſpecies of oil is not uſed for manufacturing ordinary ſoap, as its price is too high; it is only employed in the compoſition of ſoap for medicinal purpoſes. The Pharmacopœias direct us to combine two parts of almond oil with one part of concentrated alkaline lye, ſo as to make its ſpecific weight 1375, that of pure water being taken at 1000. The combination is made without the application of heat. Soaps prepared according to this proceſs require ſeveral days before they acquire a conſiſtence; they frequently contain more alkali than was neceſſary for converting the oil into ſoap, and they remain cauſtic,

ſo

ſo as not to be fit for being adminiſtered internally till after ſeveral months have elapſed. When they are manufactured with the aid of heat, and the oil is firſt treated with weak lye and afterwards with ſtronger, we obtain a ſoap which contains a more exact proportion of alkali, and which is fit for uſe on the very day that it has been prepared. In the preparation of theſe ſorts of ſoap, we muſt avoid uſing any veſſels of copper.

II. *Animal Oils.*

Tallow affords a white ſoap, which can bear the addition of a pretty conſiderable quantity of water, without loſing its conſiſtence. This ſoap ſtill retains ſomething of the ſmell of the fat employed in its compoſition. It is not neceſſary to commence the ſaponification of tallow with weak lyes; the operation ſucceds very well if we employ ſtrong lyes at the very beginning.

Hog's-lard affords a very white ſoap, which is very hard, and quite free from any diſagreeable ſmell.—As hog's lard is uſed in the preparation of food for man, it would be bad œconomy to employ it in the manufacture of ſoap, unleſs it had become rancid by age.

Rancid butter yields a very white ſoap, ſufficiently ſolid in its conſiſtence, but which ſtill retains ſomething of the ſmell of the butter employed in its compoſition.

Horſe oil is a fluid animal fat, which is prepared in the lay-ſtalls in the vicinity of Paris. It affords a white ſoap, ſufficiently ſolid, and without any diſagreeable ſmell. After being expoſed to the air for two months, in a dry place, it becomes hard, and is very fit to be uſed for the uſual purpoſes of ſoap.

III. *Oil of Colza. Oil of Rape-ſeed.*

Soap made with the oil of Colza is of a yellowiſh grey colour, and retains the ſmell peculiar to this oil; it is leſs ſolid than the ſoap made with olive oil, nor does it dry ſo well. It waſhes very well.

The ſoap manufactured with the oil of rape-ſeed is of a yellow-grey colour; it acquires a ſufficient degree of conſiſtence by expoſure to the air; but it is leſs dry than the ſoap of olive-oil: it waſhes very well.

IV. *Oil of Beech-maſt.*

The ſoap made with the oil of beech-maſt is of a dirty grey colour, and retains the ſmell peculiar to this kind of oil; it ſtill remains greaſy and clammy after having been expoſed to the air for two months in a dry ſituation.

The oil of beech-maſt cannot be manufactured into ſoap without difficulty, and it ſeems neceſſary to combine with it ſome oil which yields a dry ſoap, ſuch as olive oil.

V. *Fiſh Oils.*

Experiments have been made upon the three ſpeies of oil known by the names of train oil, cod oil, and fiſh oil.

The ſoaps manufactured with theſe three kinds of oil retain a very ſtrong fiſhy ſmell; they are hard, but far leſs dry than the ſoap made with olive oil. The ſaponaceous paſte of the cod oil is of a much dirtier yellow than that of the two other oils. Expoſure to the air has been found to give them a brown tinge approaching to red.

VI. *Hemp seed Oil.*

Hemp-ſeed oil yields a ſoap of a green colour, of little conſiſtence, and which, upon a ſlight addition of water, aſſumes the form of a paſte. By expoſure to the air in a dry ſituation, it grows ſomething harder, but not ſufficiently ſo for the common purpoſes of waſhing; it loſes its green colour, and firſt becomes white, afterwards brown.

VII. *Nut Oil, Linſeed Oil.*

The ſoap made with nut-oil is not fit for common waſhing; it is of a yellowiſh white colour, of a moderate degree of conſiſtence, greaſy and gluey; it does not grow hard by expoſure to the air, and it acquires the conſiſtence of a paſte by the addition of a very ſmall quantity of water.

The ſoap manufactured with linſeed oil is of a tolerably white colour, its ſurface ſoon grows yellow by expoſure to the air; it has a ſtrong ſmell; it is greaſy, clammy, and gluey; does not become dry by expoſure to the air, and it grows much ſofter upon the addition of a very ſmall quantity of water.

In order to complete our account of the relative qualities of ſoaps, as obtained from different kinds of oil, it remains for us to treat of the quantity of ſoaps produced by a given quantity of oil. The table which follows exhibits the reſults of experiments made upon ſoaps whoſe qualities have been examined in the preceding articles. In drawing up the table, the weight of oil converted into ſoap is ſuppoſed to be equal to 100. The firſt column denotes the ſpecies of oil which is converted into ſoap; the ſecond ſhews the weight of the ſoap thus

 obtained:

obtained: the weight ought to be considered at two different periods, namely, at the period of its being taken out of the troughs, and at the period when it has become sufficiently dry to be fit for being introduced into commerce; on this account the second column has been divided into two parts, corresponding to each of these two periods. The intention of the two other columns is sufficiently explained by their title. The drying of the soap has been carried on in a dry situation where there was a free circulation of air.

able of Manufacturing into Soap a Quantity of Oil equal in Weight to 100.

Species of Oil.	Weight of Soap.		Weight lost by evaporation.	Time of exposure to the air.
	At taking it out of the troughs.	When become saleable		
Olive oil, -	221	167	54	2 *Months*
Sweet Almonds	183	150	33	2
Tallow, - -	296	167	129	3
Hog's lard, -	283	162	121	3
Rancid butter,	366	233	133	2
Horse-oil, -	233	167	66	2
Colza, - -	167	125	42	3
Rape-seed, -	187	150	37	3
Beech mast, -	167	154	13	2
Train oil, -	167	150	17	2
Codfish oil, -	167	150	17	2
Fish oil, - -	167	150	17	2
Hempseed, -	167	150	17	2
Nut, - - -	156	158	8	2
Linseed, - -	167	150	17	2

Upon

Upon examining this table it will appear, that the oils which retain in combination the greateſt quantity of water, after being converted into ſoap, are the animal oils; and that, when a weight of oil equal to 100 is converted into ſoap, we obtain for the average-reſult a weight of ſaleable ſoap equal to 116. Olive oil, tallow, hog's lard, horſe-oil, and oil of colza, are naturally placed very near this average term.

It would be a miſtaken notion to attach to theſe calculations the idea of very rigorous preciſion; they, however, preſent an approximation to it with which we muſt content ourſelves in ſubjects of this kind.

§ II. *Of the Artifices employed with a view to defraud the Conſumer, in the Commerce with Soap.*

The object of the frauds practiſed by thoſe who adulterate ſoap, is to increaſe its weight by the admixture of leſs valuable ſubſtances, ſuch as water, chalk, horſe-cheſnuts, &c.

The moſt common method of adulterating ſoap is. Firſt to boil it in a larger quantity of water than is neceſſary for that operation; afterwards, inſtead of favouring its deſiccation by expoſing it to a free current of air in a dry place, to put it into a ſaturated ſolution of muriate of ſoda, and to leave it there till it is expoſed for ſale; by which means, it acquires ſolidity and an increaſe of weight.

We may ſee, by the table inſerted in the preceding paragraph, that the ſaponification of a weight of olive oil equal to 100, ought to afford a quantity of ſoap, equal to 221, at the time when it

it is taken out of the trough, and to 167 when the ſuperfluous water has been evaporated.

In the fraudulent manufacture, the weight of ſoap, when taken out of the troughs is equal to 300, and this is increaſed in the proportion of 10 per cent, whilſt it remains in the ſolution of muriate of ſoda; ſo that, when it is expoſed for ſale, it weighs 330 inſtead of 167, that is to ſay, about twice as much as it ought. Thus the perſons, who adulterate ſoap in this manner, defraud the conſumer of half the money which he pays for their goods. The being in the habit of ſeeing ſoaps of good quality is a pretty ſure guide for diſtinguiſhing thoſe that are adulterated. It is not poſſible to point out any ſimple proceſs by which they may be immediately detected. Expoſure in a dry place, by favouring evaporation, affords the means of finding out how much ſuperfluous water is contained in the ſoap.

§ III. *Of the manufacture of Soap without the Application of Heat.*

Soap is manufactured without the application of heat in two different ways; either with concentrated, or with ordinary lyes.

The lyes are concentrated by expoſing them to the fire; the heat cauſes the water to evaporate, and condenſes the akaline particles, whereby the lye acquires greater ſtrength and activity.

To form ſoap, one part of concentrated lye is mixed with two parts of oil; but there is very little ſaving of fuel by this method, as the concentration of the lye requires the fire, which, in the ordinary method, is employed for the boiling of the ſoap.

The

The method of proceeding with the ordinary lyes is as follows: ſuppoſe we wiſh to convert into ſoap 100 parts, by weight, of oil, we firſt mix with it 50 parts of lye at 8 degrees, and ſtir the whole well together for the ſpace of at leaſt a quarter of an hour; we then add 50 parts of lye at 18 degrees, and ſtir the mixture upwards of an hour; afterwards, we add 50 parts more of lye at 18 degrees, and ſtir the mixture till the paſte has acquired a good conſiſtence. The ſaponaceous paſte is then ſuffered to ſtand for two or three hours, after which it is put into another veſſel, and kneaded; it is then removed into the troughs, and from thence into the drying-room. It ought to remain ſeveral days in the troughs, and it will not have acquired the conſiſtence neceſſary for rendering it ſaleable till after it has remained upwards of two months in the drying-room.

The advantage of this method over the ordinary proceſs is, that it ſaves fuel; its diſadvantages are, that it conſumes a larger quantity of lye; that it excludes the lyes below 8 degrees of ſtrength, and that it produces ſoaps of an almoſt granulated conſiſtence, which require a great length of time before they become dry, and demand a great advance of unproductive capital; ſo that the ordinary methods are really preferable.

LXIX. *List of Patents for Inventions, &c.*

(Continued from Page 360.)

Ann Young, of St. James's-ſquare, in the city of Edinburgh; for an apparatus conſiſting of an oblong-ſquare box, which, when opened, preſents two faces or tables; and of various dice, pins, counters, &c. contained within the ſame, by means of which ſix different games may be played, which, beſides being amuſing and intereſting, and ſuch as children of eight years old may be taught to play, are at the ſame time an improving exerciſe upon, and ſerve to render familiar, and to impreſs upon the memory, the fundamental principles of the ſcience of muſic, particularly all the keys or modulations, major and minor, both with the common and uncommon ſignatures, muſical intervals, chords, diſcords, with their revolutions, and the moſt uſeful rules of thorough baſe.

Dated March 16, 1801.

G. F. Lenz, of Homerton, Middleſex, Tanner; for a method of conſtructing tan-pits, for tanning hides and ſkins, and for ſtriking hides by machinery.

Dated March 27, 1801.

END OF VOL. XIV.

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INDEX

TO THE

FOURTEENTH VOLUME.

A

Page

ACETIC acid. Method of preparing it, - 286

Apparatus for raising beer, ale, &c. - - 217

Arkwright, Mr. Thomas. Description of a door lock on a peculiar construction, - - - 372

B

Badollier, Citizen. Method of preparing the acetic acid, 286

Bakewell, Mr. Description of an improved Irish-car, 110

Banks, Sir Joseph, Bart. Account of experiments in cultivating rice, - - - 378

——— Effects of the equisetum palustris upon drains, 381

Barrel-organs. Patent for improvements on them, 367

Batley, Mr. Benjamin. Patent for curing and preserving herrings and sprats, - - 307

Boilers. Patent for applying heat to them, - 1

Bolter. Description of one attached to a family mill, 199

Books. Patent for an improved mode of binding them, 305

Page

Bowes, Mr. Richard. Discovery of a quarry of stones similar to the French burrs, - 189

Brass plates. Processes employed in the manufacturing of them, - - - 261

Brewing, patent for improvements in, - 150

Bridges. Patent for constructing them, - 145

Burner. Patent for one, - - - 84

Burnett, Mr. Robert. Patent for improvements in brewing and distilling, - - - 150

Burrs, French, discovery of a quarry of stones similar to them, - - - 189

C

Call, Sir John, Bart. On the smut, blights, &c. in wheat, 384

Car. Description of an improved Irish one, - 110

Cartwright, Rev. Edmund. Patent for improvements in the mechanism of steam-engines, - 361

Chaptal, M. Observations on the pine tree, and method of extracting the tar, &c. from it, - 344

Clay and Marle. Observations on them, - 31

Clulow, Mr. Thomas. Description of a loom for weaving figured ribbands, - - - 374

Collins, Mr. William. Patent for the application of sundry articles to marine purposes, - 87

Cook, Mr. Thomas. Method of turning spherical forms in wood, - - - 260

Copper. Observations and experiments on it, - 114. 201

Cordage. Patent for improvements in the tarring and manufacturing of it, - - - 231

Corn. Description of a parish or family mill and bolter for dressing it, - - - 197

D. Davey,

D

Page

Davey, Mr. Peter. Patent for improved fuel, - 174
Diſtilling. Patent for improvements in it, - 150
Ducket, Jun. Mr. Mark. Account of a hand-hoe, 112
Dying, patent for new methods of, upon cotton, linen, &c. 301

E

Evaporation, experiments on, - - 375
Equiſetum paluſtris. Effects of it upon drains, - 381

F

Fermentation, vinous. On the cauſes of it, - 129
Fire. Patent for a new method of applying it for the purpoſe of heating boilers, &c. - - 1
Fluids. On friction in them, - - 296
—— On reſiſtance of them, - - 296
Friction in fluids, - - - 296
Fuel, patent for improved, - - 174
Furnaces. Patent for applying heat to them, - 1
———— Patent for improvements on them, - 176

G

Gazeran, Citizen. On the method of preparing the pyrometrical earths of Wedgewood, - 211
Gratrix, Mr. Samuel. Patent for dying and ſtaining colours upon cotton, linen, &c. - 301

H

Harper, Mr. Henry. On the different modes of cultivating wheat, - - - 94
Haſſenfratz, J. H. On ſnow and rain—their influence on vegetation, - - - 64

Page

Heat. On the expanſion of wood by it, - . 325
Herrings. Patent for curing and preſerving them, 307
Hindmarſh, Mr. Obſervations on Rowntree's patent for applying heat to boilers, &c. - 2
Hoe. Account of a hand one, - - 112
Holmes, Mr. Deſcription of an oven heated without flues, 186
Hotchkis, Mr. John. Patent for a new mechanical power, 24
Huddart, Mr. Joſeph. Patent for improvements in the tarring and manufacturing of cordage, - 231

J

Jee, Mr. George. Deſcription of an improved mangle, 109
Jobſon, Mr. William. Experiments on the various modes of raiſing turnips, - - 37
Johnſon, Mr. William. Patent for a machine with new means of obtaining power, - - 73

K

Kali. On the real nature of it underſaturated, with carbonic acid, - - - 57
Koops, Mr. Matthias. Patent for refabricating paper, 225

L

Lamp. Patent for one, - - - 9
—— Ditto, - - - 84
Lead ſaccharum. Patent for it, - - 83
Lenſes. Patent for making them, - - 84
Liquids. Patent for an apparatus for raiſing them, 217
Locks for doors or cheſts. Deſcription of one of a peculiar conſtruction, - - 272
Longman, Mr. John. Patent for improvements in barrel-organs, - - - 367

Looms.

Page

Looms. Deſcription of improvements in thoſe for weaving figured ribbands, - - - 374

Lowits, M. On the real nature of kali underſaturated with carbonic acid, - - - 57

M

Mangle. Deſcription of an improved one, - 109

Marle and clay. Obſervations on them, - 31

Maſts. Patent for making them hollow, - 17

Metallurgy. Patent for improvements therein, - 176

Mill. Deſcription of a pariſh or family one, - 197

Muſhet, Mr. David. Patent for improvements in metallurgy and furnaces, - - - 176

N

Nancarrow, John. Deſcription of a new-invented ſteam-engine, - - - - 329

Nyſtrom, M. Nils. On the uſes of varniſh of amber, and its application to ſtained wood, - 391

O

Oats. Hints for managing thoſe ſelf-ſown, - 91

Opium. Method of preparing it in Great Britain, 309

Oven. Deſcription of one heated without flues, - 186

—— Patent for a portable one, - - 365

P

Palmer, Mr. Ebenezer. Patent for an improved mode of binding books, - - 305

Paper. Patent for refabricating it, - - 225

Patents, liſt of, - 72. 143. 215. 287. 358. 432

Parmentier, M. Obſervations on vinegar, - 402

Perpetual

Page

Perpetual motion. Obſervations on one, - . 297

Pine tree. Obſervations on it, - - 344

Power. Patent for a new mechanical one, - 24

——— Patent for a machine with new means of obtaining it, - - - - 73

——— Patent for an independent moving one, 289

——— *Mr. James.* Patent for a portable oven, - 365

Prouſt, M. Enquiry concerning tin, - 42. 140

——— Obſervations and experiments on copper, 114. 201

Pyrometers. On the method of preparing them, 211

R

Rain and ſnow. Obſervations on them, 64

Reddell, Mr. Iſaac Hadley. Patent for new-invented land and water carriages, - - 369

Rice. Account of experiments in cultivating it, 378

Rittenhouſe, Dr. On the improvement of time-keepers, 323

——— On the expanſion of wood by heat, 325

Rodwell, Mr. Joſiah. On clay and marle, - 31

Rowntree, Mr. Thomas. Patent for applying fire to the purpoſe of heating boilers, &c. - 1

——— Obſervations thereon, - 2

Ruſtall, Mr. Thomas. Deſcription of a pariſh or family mill and bolter, - - - 197

S

Sage, B. G. On the cauſes of the vinous fermentation, 129

Savigny, Mr. John Horatio. Patent for a tourniquet, 228

Shannon, Dr. Richard. Patent for improvements in brewing and diſtilling, - - - 150

Shipping, patent for ſundry articles for the uſe of, 87

Smart,

Page

Smart, Mr. George. Patent for combining masts, bowsprits, &c. hollow, - - - 17
——— Observations on the strength of timber, &c. - - - 19
Smethurst, Mr. James. Patent for a lamp and burner, and for making glass lenses, - - 84
Snow and rain. Observations on them, 64
Soap. Of the manufacture of it, - 266. 332. 416
Soft soap. Of the manufacture of it, - 416
Spherical forms. Method of turning them in wood, 260
Sprats. Patent for curing and preserving them, - 307
Staining, patent for, upon cotton, linen, &c. - 301
Staton, Mr. Thomas. Patent for an apparatus for raising liquids, - - - - 217
Steam. Method of forwarding vegetation by means of it, 235
—— *engine.* Description of a new-invented one, 329
——— Patent for improvements on them, 361
—— *house for plants.* Description of one, - 257
Stollberg. Of the manufacture of brass plates there, 261

T

Tar. Method of extracting it from the pine tree, 344
Thiville, M. J. G. J. B. de. Patent for a lamp, 9
——— *Count de.* Patent for an independent moving power, &c. - - - - 289
——— Observations on friction, &c. 294
Timber. Observations on the strength of it, - 19
Time-keepers. On the improvement of them, - 323
Tin. Enquiry concerning it, - - 42. 140
Tourniquet. Patent for one, - - 228
Turnips. Experiments on the various modes of raising them, - - - - 37

V *Varnish*

V

Page

Varnish of amber. On its uses and application to stained wood, - - - 391

Vegetation. On the influence of snow and rain upon it, 64

——— Method of forwarding it by means of steam, 235

Verdegris. Observations on it, - - 124

Vinegar. Observations on it, - - - 402

W

Wakefield, Mr. Thomas. Method of forwarding vegetation by means of steam, - - - 235

——————— Description of a steam-house, 257

Weston, Mr. Richard. Hints for managing self-sown oats and wheat, and saving ploughing and seed, 91

Wheat. Hints for managing it when self-sown, - 91

——— On the different modes of cultivating it, - 94

——— On the smut and blights in it, - 384

Whitton, Mr. John. Patent for a lead saccharum, 83

Wistar, Dr. Experiments on evaporation, - 375

Wood. On the expansion of it by heat, - 325

Wyatt, Mr. Samuel. Patent for constructing bridges, warehouses, &c. without the use of wood, 145

Y

Yellow, Naples. On the pigment so called, and the different methods of preparing it, - 134

ERRATA.

Page 106, last line, for 51 3 2 read 79 0 8.
107, first line ditto ditto.
185, line 22, for *issues not below* read *issues out below*.
2 6 12, for *Lancastershire* read *Lancashire*.
228 24, for *Fusion* read *effusion*.
338 25, for *liquefication* read *liquefaction*.

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